

NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

A GOVERNMENT USER'S PERSPECTIVE OF TESTING

by

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December 2001

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Report Documentation Page

| | | |
|--|--|--|
| Report Date 19 Dec 2001 | Report Type N/A | Dates Covered (from... to) - |
| Title and Subtitle A Government User's Perspective of Testing | Contract Number | |
| | Grant Number | |
| | Program Element Number | |
| Author(s) Richard H. Brown | Project Number | |
| | Task Number | |
| | Work Unit Number | |
| Performing Organization Name(s) and Address(es) Naval Postgraduate School Monterey, California | Performing Organization Report Number | |
| Sponsoring/Monitoring Agency Name(s) and Address(es) | Sponsor/Monitor's Acronym(s) | |
| | Sponsor/Monitor's Report Number(s) | |
| Distribution/Availability Statement Approved for public release, distribution unlimited | | |
| Supplementary Notes | | |
| Abstract | | |
| Subject Terms | | |
| Report Classification unclassified | Classification of this page unclassified | |
| Classification of Abstract unclassified | Limitation of Abstract UU | |
| Number of Pages 115 | | |

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|---|---|--|--|--|
| REPORT DOCUMENTATION PAGE | | | <i>Form Approved OMB No. 0704-0188</i> | |
| Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503. | | | | |
| 1. AGENCY USE ONLY (Leave blank) | | 2. REPORT DATE December 2001 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
| 4. TITLE AND SUBTITLE: A Government User's Perspective of Testing | | | 5. FUNDING NUMBERS | |
| 6. AUTHOR(S) Richard H. Brown | | | | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000 | | | 8. PERFORMING ORGANIZATION REPORT NUMBER | |
| 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A | | | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER | |
| 11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. | | | | |
| 12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. | | | 12b. DISTRIBUTION CODE | |
| <p>This thesis identifies and offers solutions to many common issues and challenges facing a U.S. Government weapon system developer conducting a Test and Evaluation program using the Major Range and Test Facility Base. White Sands Missile Range was used as an example. Common requirements were addressed from the perspective of a first-time U.S. Government user. The Test and Evaluation process is complicated and requires a good understanding of the Major Range and Test Facility Base structure and basic procedures. This is particularly important for the manager of a relatively small developmental program which does not have an extensive test support infrastructure. Some topics include the Major Range and Test Facility Base organization and responsibilities, White Sands Missile Range organization and capabilities, and the Universal Documentation System. In addition, a presentation of practical lessons-learned from both Major Range and Test Facility Base users and operators provides a valuable resource base for all test program managers.</p> | | | | |
| 14. SUBJECT TERMS Flight Termination System, Joint Analysis Team, Major Defense Acquisition Program, Major Range and Test Facility Base, Operations Directive, Operations Requirements, Program Introduction, Program Requirements Document, Program Support Plan, Range Commanders Council, Range Environment, Range Safety, Safe and Arm, Statement of Capability, System Test and Analysis Directorate, Target, Test and Evaluation, Test Hardware, Test Planning, Test Schedule, Universal Documentation System, White Sands Missile Range | | | 15. NUMBER OF PAGES 115 | |
| | | | 16. PRICE CODE | |
| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT UL | |

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18

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A GOVERNMENT USER'S PERSPECTIVE OF TESTING

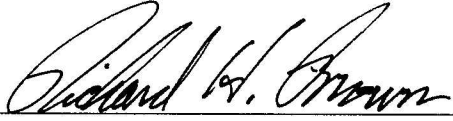
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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN PROGRAM MANAGEMENT

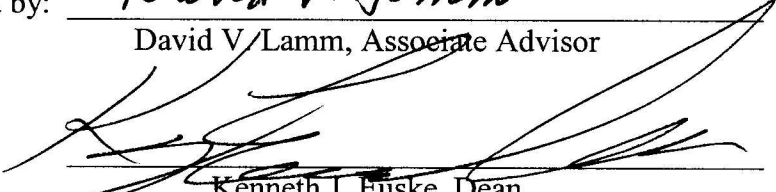
from the

**NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

This thesis identifies and offers solutions to many common issues and challenges facing a U.S. Government weapon system developer conducting a Test and Evaluation program using the Major Range and Test Facility Base. White Sands Missile Range was used as an example. Common requirements were addressed from the perspective of a first-time U.S. Government user. The Test and Evaluation process is complicated and requires a good understanding of the Major Range and Test Facility Base structure and basic procedures. This is particularly important for the manager of a relatively small developmental program which does not have an extensive test support infrastructure. Some topics include the Major Range and Test Facility Base organization and responsibilities, White Sands Missile Range organization and capabilities, and the Universal Documentation System. In addition, a presentation of practical lessons-learned from both Major Range and Test Facility Base users and operators provides a valuable resource base for all test program managers.

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ACKNOWLEDGMENTS

The author wants to thank Professor David F. Matthews for his guidance and support during the preparation of this thesis. His keen insight into the Test and Evaluation process was of immense help.

The author wants to thank Karen Brown for her help in proofreading this thesis. Her editing skill eliminated many errors and resulted in a much better document.

The author also wants to thank the following users and operators of the Major Range and Test Facility Base who graciously agreed to be interviewed as part of the research process. Their wealth of practical knowledge is truly a national resource.

Mike Alvarez

Joaquin Castro

Angela Delgado

Robert DeRosa

William Evans

Tom Hamilton

Larry Haynes

Dan Hicks

Colin Lees

Larry Moore

David Ribail

Victor Robbins

Herbert M. Sanborn

Ronald Smith

Phillip Terry

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis was to identify and explain the significant issues and challenges facing first-time United States (U.S.) Government users of the Major Range and Test Facility Base (MRTFB). White Sands Missile Range (WSMR) was used as an example. This thesis addressed MRTFB requirements from the perspective of a first-time U.S. Government user. It is also intended to serve as a guide for addressing issues such as cost, schedule, and priority.

B. BACKGROUND

Test and Evaluation (T&E) is key to the Department of Defense acquisition process. Nearly all acquisition programs use the MRTFB. However, this is often a complicated process and therefore a good understanding of the MRTFB structure and basic procedures is essential for planning an effective test program. This is particularly important for managers of relatively small developmental programs who do not have the extensive internal test support infrastructure that is typically found in a Major Defense Acquisition Program (MDAP). In addition, practical lessons-learned from both MRTFB users and operators provide a valuable resource base for all test program managers.

C. THESIS OBJECTIVE

The objective of this thesis was to identify and offer solutions to the common, significant issues and challenges facing first-time Government users of the MRTFB. The WSMR was used as an example. This thesis attempted to demystify MRTFB requirements from the perspective of a first-time Government user. In addition, it is intended to serve as a guide for addressing issues such as cost, schedule, and priority.

D. RESEARCH QUESTIONS

The primary research question of this thesis is: How can a first-time U.S. Government user of the Major Range and Test Facility Base overcome the significant issues and challenges of conducting a successful test program?

Subsidiary research questions are:

- (1) What is the MRTFB?

- (2) What is the process for obtaining support from a MRTFB installation?
- (3) What are typical issues and questions (cost, schedule, priority) facing a first-time U.S. Government user?
- (4) How might these issues and questions be resolved?
- (5) What are some possible strategies and plans for effective and efficient use of a MRTFB installation?
- (6) What are some potential strategies that the MRTFB could use to improve customer service?

E. SCOPE AND LIMITATIONS

This thesis examined the significant issues and challenges facing first-time U.S. Government users of the MRTFB. The WSMR was used as the primary example of an MRTFB installation. Discussion of other MRTFB installations was limited to standardization of documentation. The focus was on how a first-time U.S. Army program can establish and execute a successful test program at WSMR. The organization of WSMR and the use of the Universal Documentation System (UDS) were key components of the analysis. An examination of foreign test programs using the MRTFB and U.S. programs using foreign test ranges was beyond the scope of this thesis.

F. METHODOLOGY

1. Data Collection Methodology

The thesis research involved telephone interviews with MRTFB users and operators and analysis of documents that MRTFB operators provide to users. Telephone interviews were conducted with representatives from both Government and Industry who had experience testing at WSMR. They provided the MRTFB user perspective. Telephone interviews were conducted with representatives from both Government and Support Contractor organizations at WSMR. They provided the MRTFB operator perspective. User guides, UDS manuals, and related documents published by MRTFBs were analyzed. They provided a description of the formal framework by which test programs interact with a MRTFB.

2. Data Analysis Methodology

The MRTFB documentation was analyzed to identify user and operator requirements. The data obtained from the telephone interviews were analyzed to determine the perspectives of both WSMR users and the operators. All these data were used to identify significant issues or problems.

3. Conclusions and Recommendations Methodology

Conclusions and recommendations were derived based on the data analysis. If implemented, they should result in more effective customer service by WSMR and, potentially, the rest of the MRTFB. In addition, a first-time U.S. Government user should be able to conduct a more efficient T&E program.

G. THESIS ORGANIZATION

The thesis is organized into five chapters.

Chapter I: Introduction – This chapter presents the purpose, background, objective, research questions, scope and limitations, methodology, and organization of the thesis.

Chapter II: Test Infrastructure – This chapter describes the framework of the DoD T&E infrastructure, MRTFB, Range Commanders Council (RCC), WSMR, and the UDS.

Chapter III: Data Presentation – This chapter presents documentary data on MRTFB, WSMR, and UDS operations. It also describes the data collection process used during interviews with both MRTFB users and operators.

Chapter IV: Data Analysis – This chapter presents an analysis of data from Chapters II and III and Appendix C. It identifies the most important issues and lessons-learned from MRTFB users and operators and is organized topically.

Chapter V: Conclusions and Recommendations – This chapter presents conclusions and recommendations for both MRTFB users and operators.

Appendices containing an acronym list, interview data, and reference material on the UDS.

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II. TEST INFRASTRUCTURE

A. DEPARTMENT OF DEFENSE TEST INFRASTRUCTURE

The DoD has a massive T&E infrastructure. The Secretary of Defense delegated MRTFB management responsibility to the Under Secretary of Defense (Acquisition, Technology & Logistics) (USD(AT&L)) and the Director, Operational Test and Evaluation (DOT&E) and on to the Service Secretaries. From there, the chain-of-command flows from the Secretary of the Army, to the U.S. Army Test and Evaluation Management Agency (TEMA), and to the U.S. Army Test and Evaluation Command (ATEC). This is shown in Figure 1. [Ref. 1]

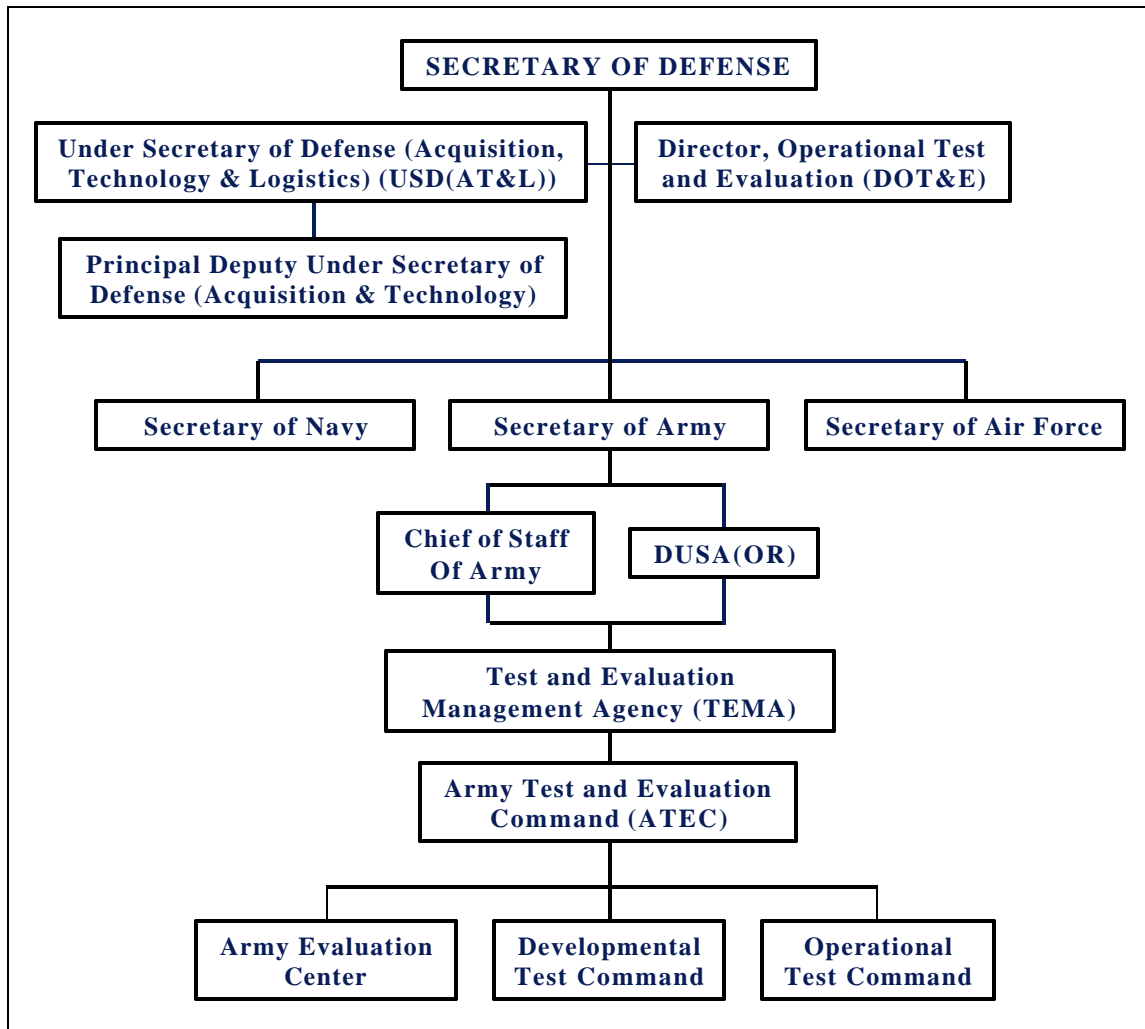


Figure 1. Test and Evaluation Flow-down to the Army [From: Ref. 1]

B. MAJOR RANGE AND TEST FACILITY BASE

The MRTFB is a set of major test installations, facilities, and ranges used to support Department of Defense (DoD) T&E missions. The MRTFB contains advanced and unique facilities and capabilities that make them national assets. The MRTFB and responsible DoD organizations are listed in Table 1. [Ref. 1] MRTFB resource data and contact information are contained in Appendix E.

| | |
|-----------------------|--|
| U.S. Army | White Sands Missile Range , WSMR, NM (including Electronic Proving Ground at Fort Huachuca, AZ) High Energy Laser Systems Test Facility , WSMR, NM Reagan Test Site , Kwajalein Atoll Yuma Proving Ground , Yuma, AZ (includes Cold Regions Test Center , AK and Tropic Test Center , AZ/HI/PR) Dugway Proving Ground , Dugway, UT Aberdeen Test Center , Aberdeen, MD |
| U.S. Navy | Naval Air Warfare Center-Weapons Division , Point Mugu, CA Naval Air Warfare Center-Weapons Division , China Lake, CA Naval Air Warfare Center-Aircraft Division , Patuxent River, MD Atlantic Undersea Test and Evaluation Center , West Palm Beach, FL/Andors Island Pacific Missile Range Facility , Kauai, HI |
| U.S. Air Force | 30th Space Wing , Vandenberg, CA 45th Space Wing , Patrick AFB, CA Air Force Air Armament Center 46th Test Wing , Eglin AFB, FL Air Force Development Test Center (including the 46 th Test Group at Holloman AFB, NM) Arnold Engineering Development Center , Tullahoma, TN Nevada Test and Training Range , Nellis AFB, NV Air Force Flight Test Center , Edwards AFB, CA Utah Test and Training Range , Hill AFB, UT |
| Department of Defense | Joint Interoperability Test Command , Fort Huachuca, AZ |

Table 1. Major Range and Test Facility Base. [From: Ref. 1]

The MRTFB “exists primarily to provide T&E for DoD decision-makers and support T&E needs of DoD research programs and weapon system development programs. ... Other U.S. Government Agencies (Federal, state, and local) and allied foreign governments, and defense contractors may be permitted to use the MRTFB.

Private organizations and commercial enterprises may use the MRTFB as authorized by Congress and any subsequent policy from the USD(AT&L).” Non-DoD users reimburse the DoD for their MRTFB activities. [Ref. 2:para. 3.1.2-3.1.3]

The USD(AT&L) has overall responsibility for the MRTFB. The USD(AT&L) works through the DOT&E and the Deputy Director, Operational Test and Evaluation/Resources and Ranges (DDOT&E/RR) to manage the MRTFB. The organizational chart is shown in Figure 2. [Ref. 1]

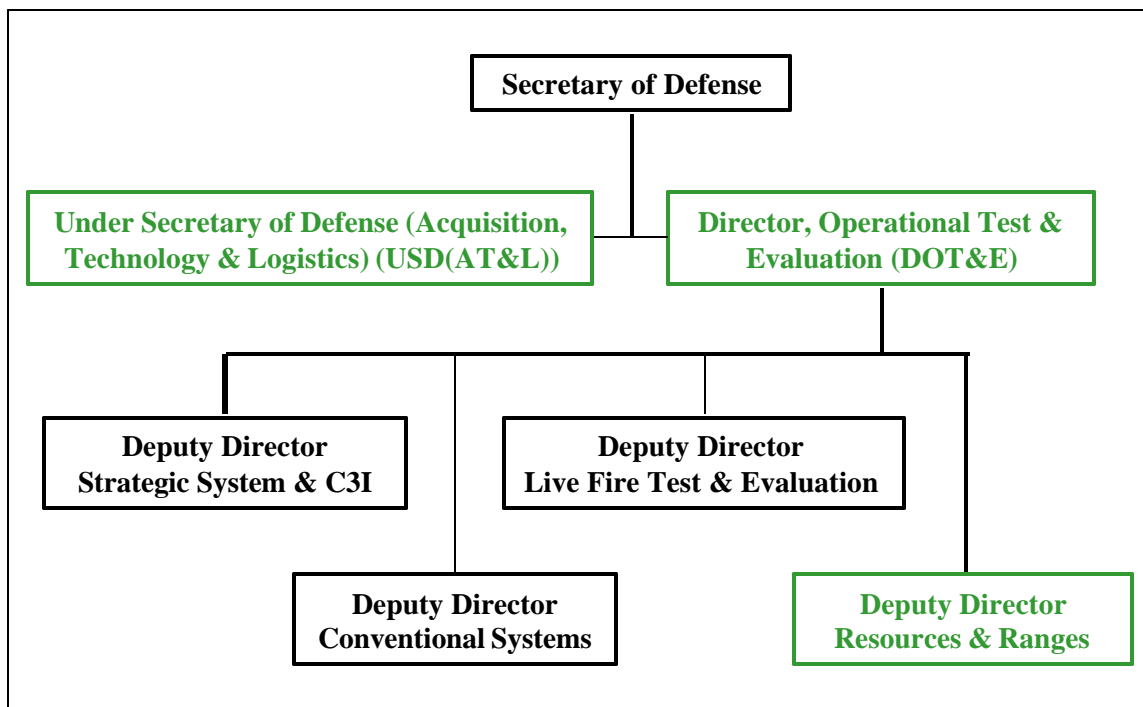


Figure 2. Department of Defense Test and Evaluation Responsibilities [From: Ref 1]

C. RANGE COMMANDERS COUNCIL

The RCC is an organization of Government test ranges established outside formal DoD structures. Members work together to promote affordable technical capabilities to test and operate U.S. weapon systems. The RCC provides a framework for member test ranges to establish technical standards, identify common needs, develop common solutions, initiate joint procurements, exchange equipment, address technical innovations, and identify applications for technical innovations. [Ref.3:pp. 1-3] Membership of the RCC is listed in Table 2.

| | |
|----------------------|--|
| U.S. Army | White Sands Missile Range (including Electronic Proving Ground at Fort Huachuca, AZ) Kwajalein Missile Range Yuma Proving Ground Dugway Proving Ground Aberdeen Test Center National Training Center |
| U.S. Navy | Naval Air Warfare Center-Weapons Division, Point Mugu and China Lake Naval Air Warfare Center-Aircraft Division, Patuxent River Naval Undersea Warfare Center Division Newport Naval Undersea Warfare Center Division Keyport Atlantic Fleet Weapons Training Facility Pacific Missile Range Facility |
| U.S. Air Force | 30th Space Wing 45th Space Wing Arnold Engineering Development Center Air Force Air Warfare Center Air Force Flight Test Center Utah Test and Training Range Air Armament Center Barry M. Goldwater Range |
| Department of Energy | Nevada Test Site |

Table 2. Range Commanders Council Members [From: Ref. 4]

D. WHITE SANDS MISSILE RANGE

The WSMR is the largest overland test range in the U.S. It is part of the MRTFB and is a leading member of the RCC. It is regularly used by customers from the Army, Navy, Air Force, and other authorized users. ATEC is responsible for WSMR. [Ref. 5] The Army T&E Community is shown in Figure 3. [Ref. 6]

E. UNIVERSAL DOCUMENTATION SYSTEM

The UDS is the formal documentation system established by RCC members. The UDS gives users and support agencies a common format to use in identifying support requirements and the capabilities to meet those requirements. It also documents the commitment by both the user and the support agency to conduct the activities upon which they have mutually agreed. The UDS is designed and controlled by the RCC Documentation Group (DG). The UDS is a key element in any testing at RCC member ranges. [Ref. 7:p. 1-1]

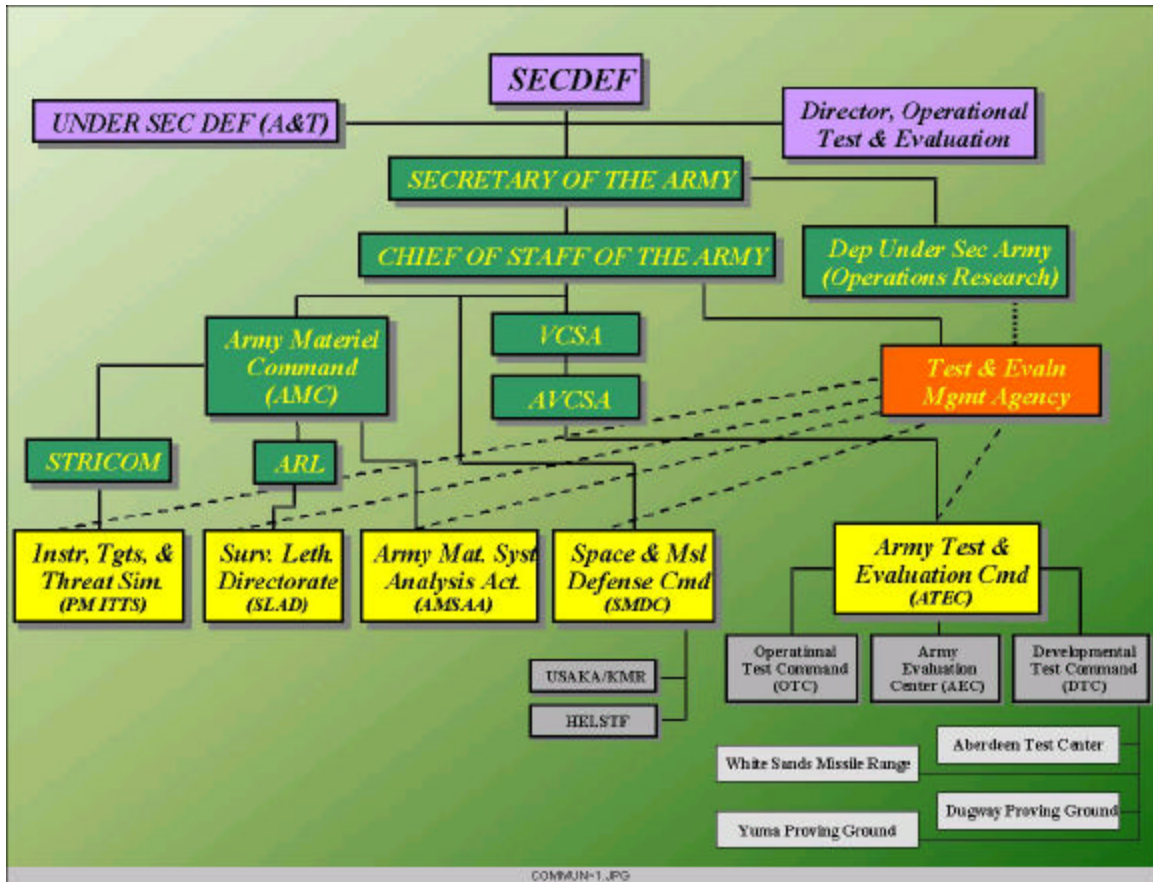


Figure 3. Army Test and Evaluation Community [From: Ref. 6]

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III. DATA PRESENTATION

A. MAJOR RANGE AND TEST FACILITY BASE

The MRTFB is a set of major test installations, facilities, and ranges that exists primarily to support DoD weapon system testing. The DoD sponsors the MRTFB and is its primary user.

1. Under Secretary of Defense for Acquisition, Technology, and Logistics Responsibilities

The USD(AT&L) has overall responsibility for the MRTFB. The USD(AT&L) works through the DOT&E to establish MRTFB policy, ensure adequate capabilities, preclude unnecessary duplication, expand or reduce capabilities as necessary, and manage investments. [Ref. 2:para. 4.1]

2. Secretaries of the Military Departments and the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence Responsibilities

The Secretaries of the Military Departments and the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence manage and operate their MRTFB installations and activities. They support tests and programs within their capabilities, manage investments in their installations and activities, develop a system to collect reimbursement from users, modernize their capabilities, consolidate test facilities, and assess environmental consequences of proposed activities. [Ref. 2:para 4.2]

3. Installation or Activity Commander Responsibilities

Each MRTFB installation or activity commander is responsible for developing operating and planning budgets, producing a development and operations master plan, producing a capabilities and procedures guide for users, assisting prospective users with test planning, collecting reimbursement from users, providing an appropriate infrastructure for testing, coordinating public affairs plans, and ensuring safe operations. [Ref. 2:para. 4.2.9]

4. User Responsibilities

Each MRTFB user must provide the test installation or activity with timely and complete notification of support requirements and system performance characteristics. The installation or activity will specify the required format for the notification. The user

must obtain prior approval before entering into a contract requiring MRTFB support or bringing user-supplied ground support equipment to a test installation or activity. System safety and environmental issues must be coordinated with the test installation or activity. The user must ensure that all planned tests comply with any applicable treaties and other international agreements, such as the ground-launched missile flight range restrictions imposed by the Intermediate Nuclear Forces Treaty or the test range restrictions imposed by the Antiballistic Missile Treaty. The user must reimburse the test installation or activity for all support costs. [Ref. 2:para. 4.2.10]

B. WHITE SANDS MISSILE RANGE

The WSMR is the largest overland test range in the U.S. It is located in south-central New Mexico, north of El Paso, Texas and northeast of Fort Bliss. It covers approximately 3200 square miles and has lease/partnering agreements that allow it to be expanded to 7100 square miles, if required. [Ref. 9:p. 1] A map of WSMR and the surrounding area is shown in Figure 4.

The U.S. Army Test and Evaluation Command manages the WSMR. It is part of the MRTFB and is a leading member of the RCC. It is regularly used by customers from the Army, Navy, Air Force, and other authorized organizations. The organization chart for WSMR is shown in Figure 5. [Ref. 5] These various elements of WSMR work together to support testing, as shown in Figure 6.

1. Range Control

The Range Control Center (RCC) in Building 300 exercises integrated, real-time control of testing. The RCC's real-time data display capability is key to test mission control, flight and ground safety, and range control. Construction is underway on the J. W. Cox Range Control Center, which will replace the RCC when it is completed. [Ref. 9:pp. 1-2]

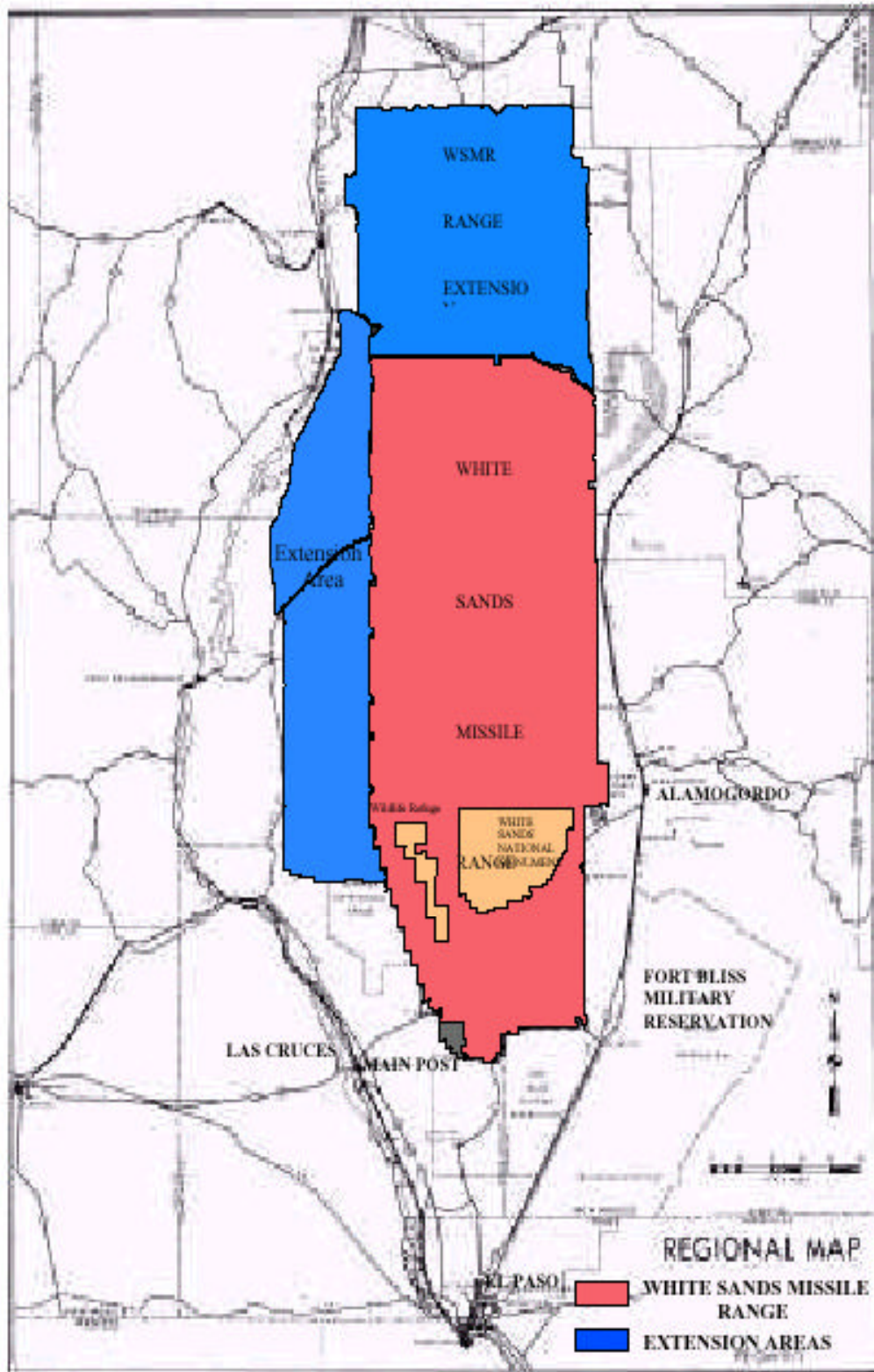


Figure 4. White Sands Missile Range and Surrounding Area [From: Ref. 9:p. vi]

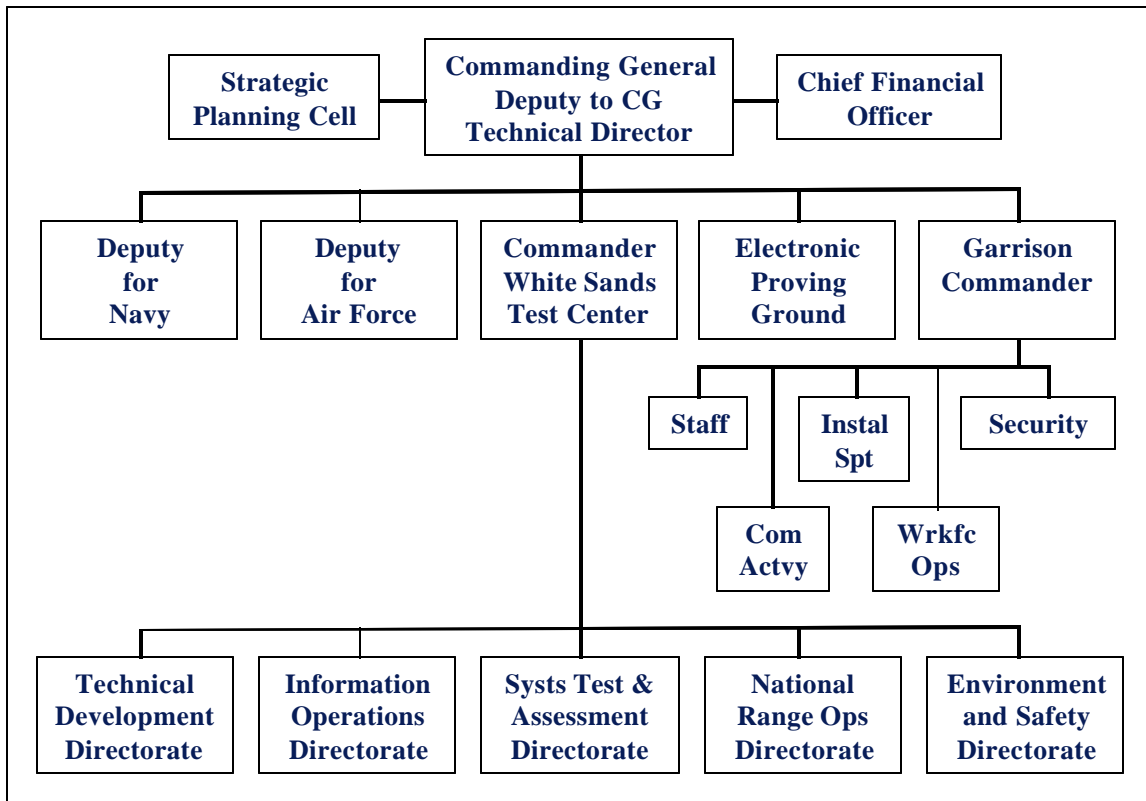


Figure 5. White Sands Missile Range Organization [From: Ref. 5]

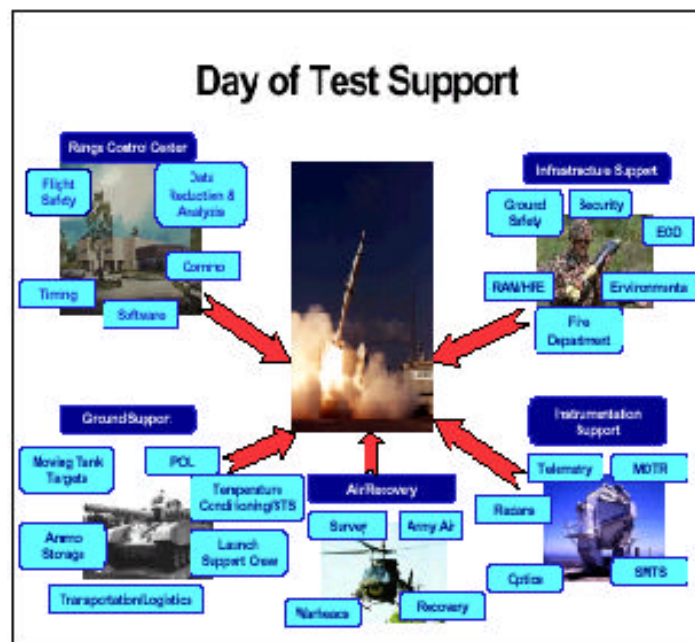


Figure 6. White Sands Missile Range Test Support [From: Ref. 9:p. 5]

2. Range Instrumentation

A wide variety of test facilities and instrumentation is available at WSMR, one of the best-instrumented test ranges in the world. Some of the instrumentation systems available include telemetry, radar, optics, interferometer, and Global Positioning System. Many unique mission data requirements can also be accommodated. A good user reference for test mission support and facilities capabilities is the *White Sands Missile Range Capabilities Handbook*. The 2001 issue is the most recent version. [Ref. 9]

3. Laboratory Capabilities

A wide variety of laboratories staffed by experienced engineers, physicists, mathematicians, and other analysts is available at WSMR. Capabilities include fixed and portable temperature chambers, dynamic vibration facility, metallurgy laboratory, chemistry laboratory, and warhead test facility. [Ref. 9:pp. 28-31]

4. Environmental and Safety Support

The WSMR provides environmental and safety support to all users. This is essential to ensure that all programs comply with a complex array of Federal laws, state laws, Executive Orders, regulations, directives, instructions, policies, and procedures. [Ref. 9:p. 60]

C. SYSTEMS TEST & ASSESSMENT DIRECTORATE

The Systems Test and Assessments Directorate (STAD) conducts T&E activities at WSMR. It works through three Divisions, as shown in Figure 7. [Ref. 5]

1. Applied Sciences Division

The Applied Sciences Division provides technical experts and equipment for stockpile-to-target testing.

2. System Performance and Assessments Division

The System Performance and Assessments Division provides performance assessments of test programs.

3. Program Management and Test Division

The Program Management and Test Division provides Project Management Office (PMO) customers with a single point-of-contact interface with WSMR for T&E activities. Customer interaction with the Program Management and Test Division is a fundamental element in conducting T&E activities on WSMR.

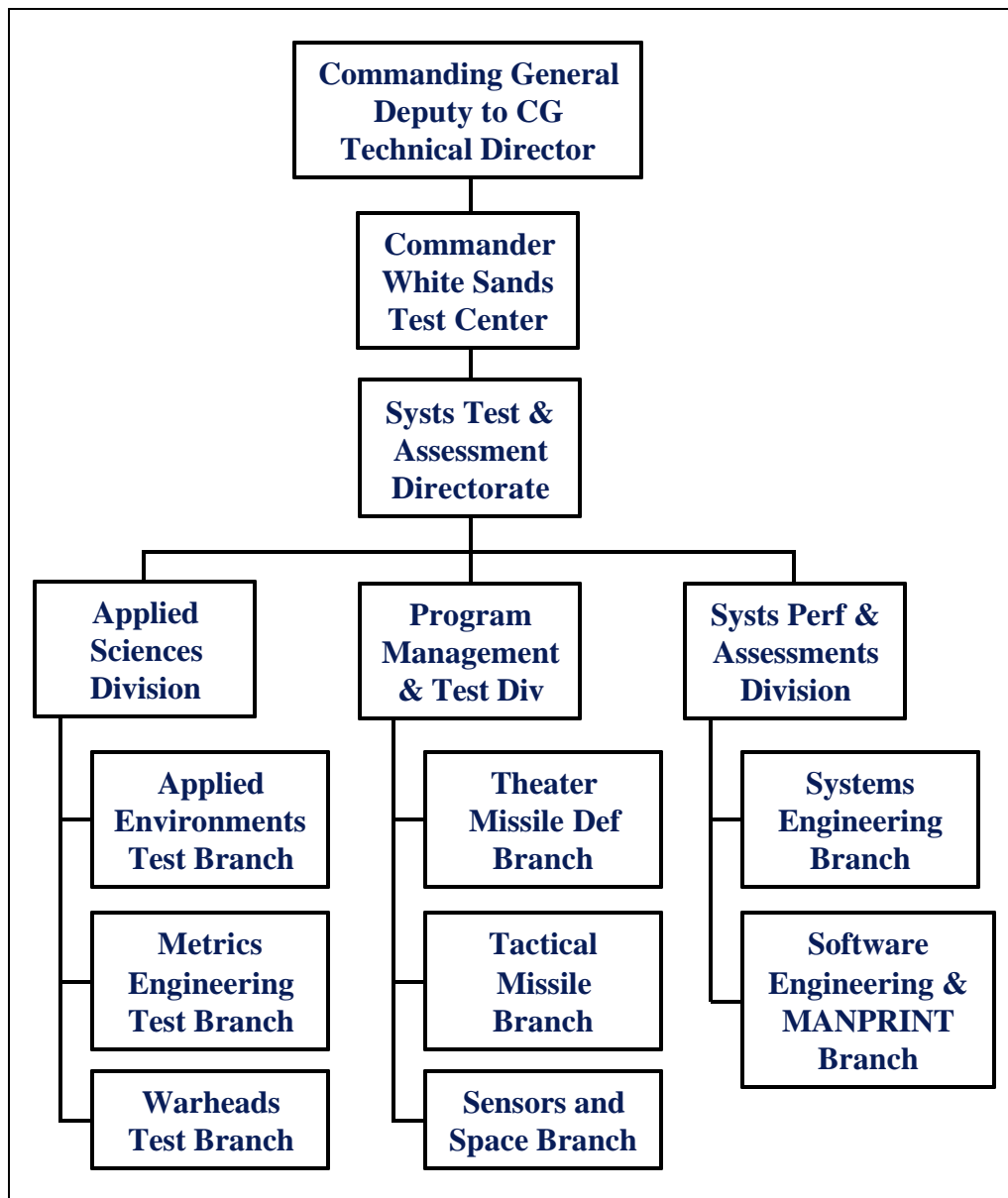


Figure 7. Systems Test and Assessments Directorate Organization [From: Ref. 5]

a. Theater Missile Defense Branch

The Theater Missile Defense Branch provides planning, testing, and reporting for Theater Air and Missile Defense (TAMD) system tests. This includes TAMD missile and related sensor tests.

b. Tactical Missile Branch

The Tactical Missile Branch provides planning, testing, and reporting for “deep attack artillery shells, anti-tank weapons and submunitions, ground targets support, Theater Missile Defense targets, and short range ground-to-air missile systems.”

c. Sensor and Space Branch

The Sensor and Space Branch provides planning, testing, and reporting for “Theater Missile Defense and National Missile Defense, air defense battle management, and space related test programs and applications.” [Ref. 1]

D. UNIVERSAL DOCUMENTATION SYSTEM

The UDS is an essential element of all test programs at WSMR. The primary user reference for the UDS is RCC DG Document 501-97, *Universal Documentation System*. The November 1997 issue is the most recent version. Excerpts are printed in Appendix D. [Ref. 7]

1. Universal Documentation System Organization

There are three levels of UDS documentation. They document the dialogue between the user and the support agency. At each level, the user submits the first document and the support agency responds with a corresponding document. Relatively simple test programs may only need to complete levels one and three while more complex test programs must complete all three levels. The documentation cycle is shown in Figure 8. [Ref. 8:p.5]

a. Level 1

The user writes the Program Introduction (PI) and the support agency responds with the Statement of Capability (SC). These documents initiate support planning.

b. Level 2

The user writes the Program Requirements Document (PRD) and the support agency responds with the Program Support Plan (PSP). These documents provide more detailed information on the test requirements or program information for more complex testing.

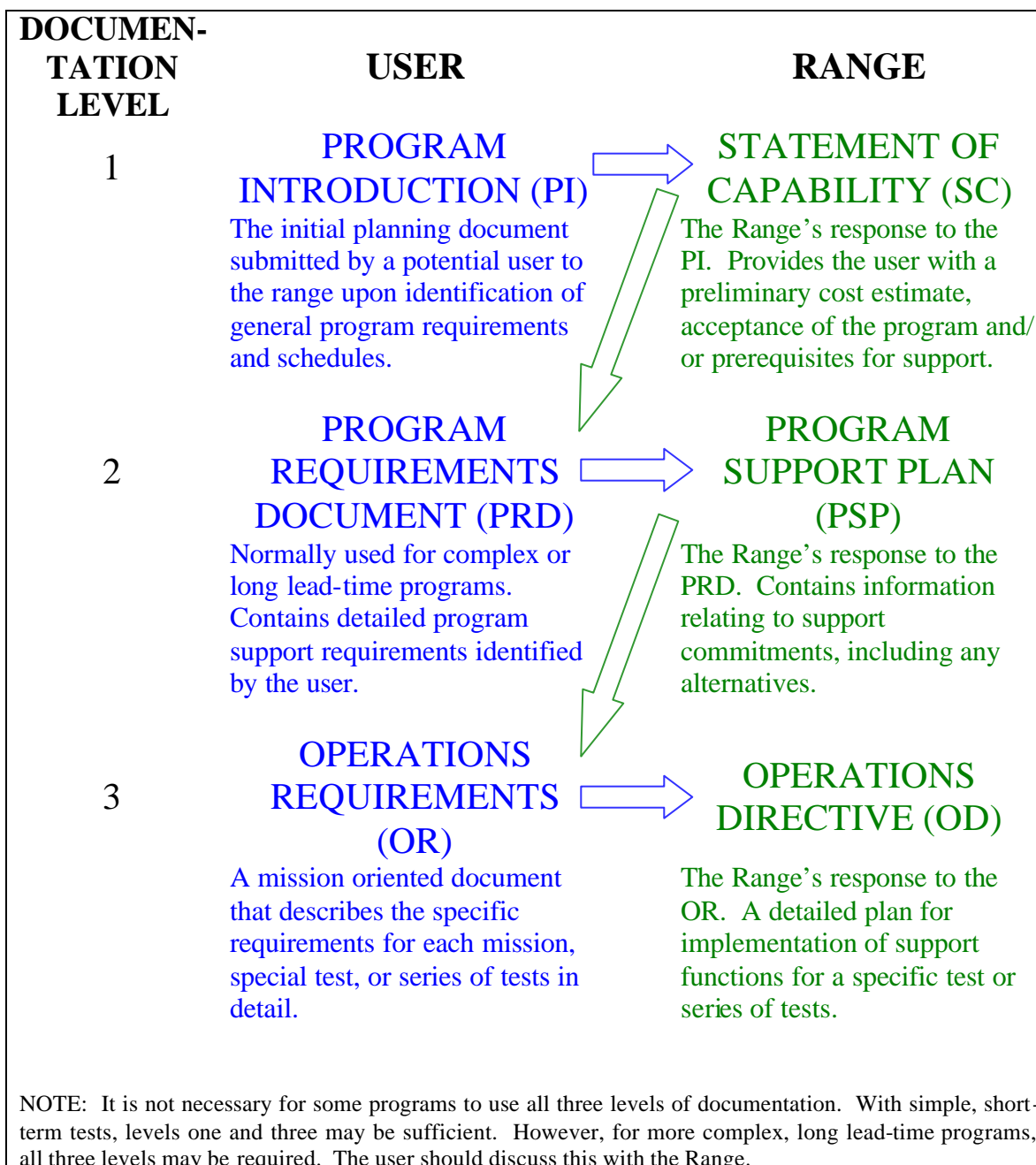


Figure 8. Universal Documentation System Components [From: Ref. 8:p.5]

c. Level 3

The user writes the Operation Requirement (OR) and the support agency responds with the Operations Directive (OD). These documents identify detailed requirements and support for a specific test or series of similar tests.

2. Universal Documentation System Applications

The UDS is intended to be flexible enough to accommodate both a simple test with a single support agency and a complex test series with multiple users and multiple support agencies. This is illustrated in Figure 9. [Ref. 8:p. 7]

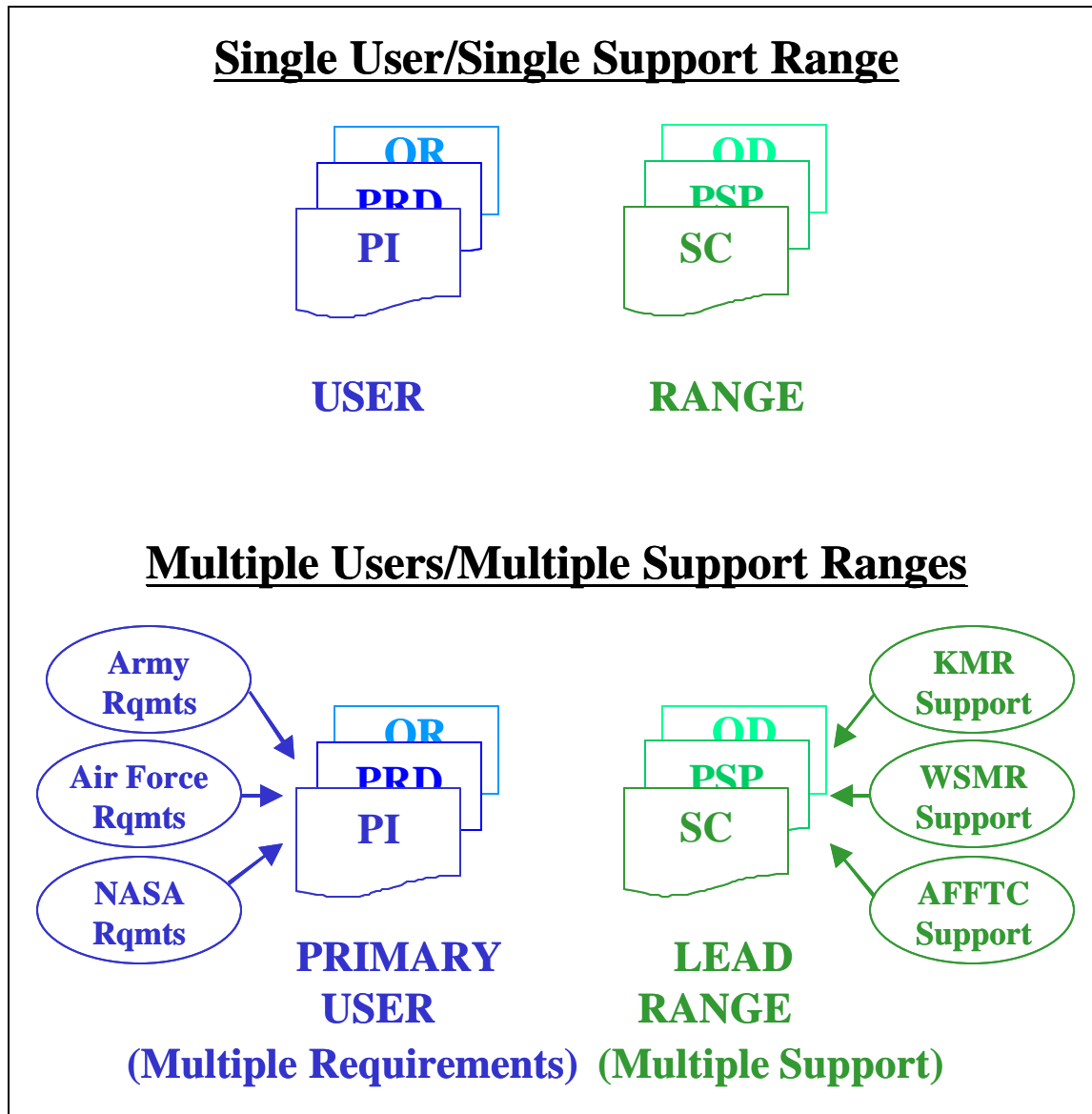


Figure 9. Universal Documentation System for Different Magnitudes of Testing [From: Ref. 8:p. 7]

E. INPUT FROM WHITE SANDS MISSILE RANGE USERS AND OPERATORS

Telephone interviews were conducted with WSMR users and operators. The interviewees provided excellent feedback on their experiences conducting test programs at WSMR. To assure open and frank input, the interviewees were promised partial anonymity. The interviewees are identified by name, but test program comments are not associated with any individual. A list of the interviewees is contained in Appendix B. Their comments, in random order, are contained in Appendix C. Transcription of the comments attempted to capture main thoughts rather than exact words. The comments were also modified slightly to remove most references to specific events or programs. This was to prevent association of specific comments with any individual.

1. White Sands Missile Range Users

The WSMR users represented both Government and Industry. Their test experience base ranged from working on a single program for a short time to working on multiple programs spanning decades.

a. Administrative Questions

The interviewees were asked the following administrative questions. Their answers appear in Appendix B.

Name?

Job Title?

Organization?

Name of the test program?

Approximate dates of WSMR testing?

Location of WSMR testing?

Type testing?

Approximate size of test program?

b. Test Program Questions

The interviewees were asked the following test program questions. Their answers appear in Appendix C.

Description of interface with WSMR?

Description of interface with the UDS?

Description of significant issues or problems with WSMR?

Identification of lessons-learned?

2. White Sands Missile Range Operators

The WSMR operators represented both the Government and the support contractor communities. Their WSMR experience base ranged from 12 to 27 years.

a. Administrative Questions

The interviewees were asked the following administrative questions. Their answers appear in Appendix B.

Name?

Job Title?

WSMR Organization?

Approximate years of National Test Range experience?

Typical test program?

b. Test Program Questions

The interviewees were asked the following test program questions. Their answers appear in Appendix C.

Description of interface with customer?

Description of interface with the UDS?

Description of significant issues or problems with customers?

Identification of lessons-learned?

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IV. DATA ANALYSIS

A. MAJOR RANGE AND TEST FACILITY BASE

The MRTFB is a set of major test installations, facilities, and ranges used to support the DoD's T&E mission. The MRTFB chain-of-command goes from the Secretary of Defense to the USD(AT&L) and DOT&E. From there, it flows down to the Service Secretaries. The Secretary of the Army delegates responsibility to TEMA, to ATEC, and finally to WSMR. The organizational diagrams are shown in Figures 1, 2, and 3.

The WSMR was used as an example of a MRTFB facility. The largest overland test range in the U.S., the WSMR covers approximately 3200 square miles and has lease/partnering agreements that allow it to be expanded to 7100 square miles. It is regularly used by customers from the Army, Navy, Air Force, and other authorized organizations. The WSMR organization chart is shown in Figure 5.

B. MAJOR RANGE AND TEST FACILITY BASE USER/OPERATOR INTERFACE

A symbiotic relationship exists between a DoD weapon system PMO and a MRTFB installation or activity. The PMO cannot complete the essential T&E portion of development without test range support. The primary reason the test range exists is to support PMO T&E programs. A cooperative, team-oriented approach between PMO and MRTFB personnel is the norm. While some level of conflict and disagreement must be expected, the overall system is working well and is successfully completing the T&E mission for which it was intended.

1. White Sands Missile Range Project Engineer

The Project Engineering system in place at WSMR works very well. When a PMO approaches WSMR with a request for T&E support, the STAD appoints a Project Engineer to work with the PMO. The Program Management and Test Division is responsible for flight and associated ground tests. The Project Engineer will come from the Theater Missile Defense Branch, the Tactical Missile Branch, or the Sensor and Space Branch, depending on the type system being tested. The Project Engineer is the single point-of-contact for all PMO activities at WSMR.

a. Project Engineer Counterpart

It is incumbent on the PMO to designate a Director of Testing as the counterpart to the STAD Project Engineer. All test programs encounter situations where the PMO must choose from among various options. The PMO Director of Testing must have the authority to make those decisions and commit the PMO to a position. Some authority must be delegated to more junior PMO personnel within specified boundaries. However, everyone must understand that the Director of Testing is the final decision authority for the PMO. Anything less will result in chaos.

b. Project Engineer Relationships

It is critical that PMO personnel establish a good working relationship with the STAD Project Engineer. Typically, WSMR assigns very capable and experienced engineers to Project Engineer positions. It is normal for PMO test personnel to develop a close, cooperative, working relationship with the Project Engineer. Senior PMO personnel often give the Project Engineer most of the credit for a successful test program. In the very rare cases where the PMO personnel and the Project Engineer had a poor working relationship, the test program suffered. The Project Engineer can make or break a test program.

c. Project Engineer Responsibilities

The Project Engineer is in the gap between the PMO and WSMR. The Project Engineer has to determine what the PMO really wants from a test and how WSMR can economically fulfill those test requirements. The Project engineer is often the individual with the best understanding of both sides. The UDS is used to formally transmit the PMO requirements and the WSMR support capabilities. The Project Engineer is often involved in helping both PMO and WSMR personnel write their UDS inputs.

The Project Engineer is the key coordinator for a test. The Project Engineer coordinates test support from the National Range, telemetry, optics, radar, and whatever else is needed for the test. This includes resolving any problems, changes, and substitutions that may occur before a test. Good coordination with the Test Conductor is critical as the test date approaches. The Project Engineer should have good, long-term

working relationships with all the test elements at WSMR. Expediency in supporting an individual test does not justify damaging those long-term relationships.

2. White Sands Missile Range Test Conductor

The STAD assigns a Test Conductor to work with the Project Engineer. Initially, the Test Conductor is in a support role to the Project Engineer for PMO interface. That role slowly reverses during the period leading up to the test. By test-day, the Test Conductor is in the lead for PMO support. On test-day, the Test Conductor is the PMO's single point-of-contact with WSMR for conducting the test.

a. Test Conductor Relationships

It is critical that PMO personnel establish a good working relationship with the STAD Test Conductor. Typically, WSMR assigns very capable and experienced personnel to Test Conductor positions. It is normal for PMO test personnel to develop a close, cooperative, working relationship with the Test Conductor, very similar to that with the Project Engineer. Senior PMO personnel often give the Test Conductor credit, along with the Project Engineer, for a successful test program. Like the Project Engineer, the Test Conductor can make or break a test program.

b. Test Conductor Responsibilities

On test-day, the Test Conductor is in the gap between the PMO and WSMR. The Test Conductor is responsible for ensuring that the test is conducted as planned. This includes real-time decision responsibility for resolving last-minute problems, changes, and substitutions. Personnel at a large PMO reported that they had been assigned the same Test Conductor for a number of years. The experience and skill of that Test Conductor were cited as being major factors in the successful completion of numerous T&E objectives over a period of many years.

3. Major Range and Test Facility Base User/Operator Communications

Good communications are an essential element of a successful T&E program. It is never too early for the PMO to open a dialogue with MRTFB operators. Communications must be frank, open, and continuous over the life of the T&E program.

a. Consultations

Experienced testers from MRTFB facilities and activities are a valuable resource available to the PMO well before T&E activities begin. Consideration should be

given to using MRTFB personnel as consultants as early as Operational Requirements Document (ORD) development. They can offer unique insights into the feasibility and expense of demonstrating weapon system performance in the T&E environment. They can also provide valuable suggestions on both the type and number of tests required to demonstrate key performance parameters. Finally, they can help develop a reasonable T&E cost estimate early in the budgeting process.

b. Means of Communication

The PMO must use all available means of communications with the MRTFB, as illustrated in Figure 10. Weapon system T&E can be incredibly complex. For a major test to be successful, hundreds of people must work together to complete thousands of technically demanding tasks. The devil is in the details. Good communications are absolutely essential.

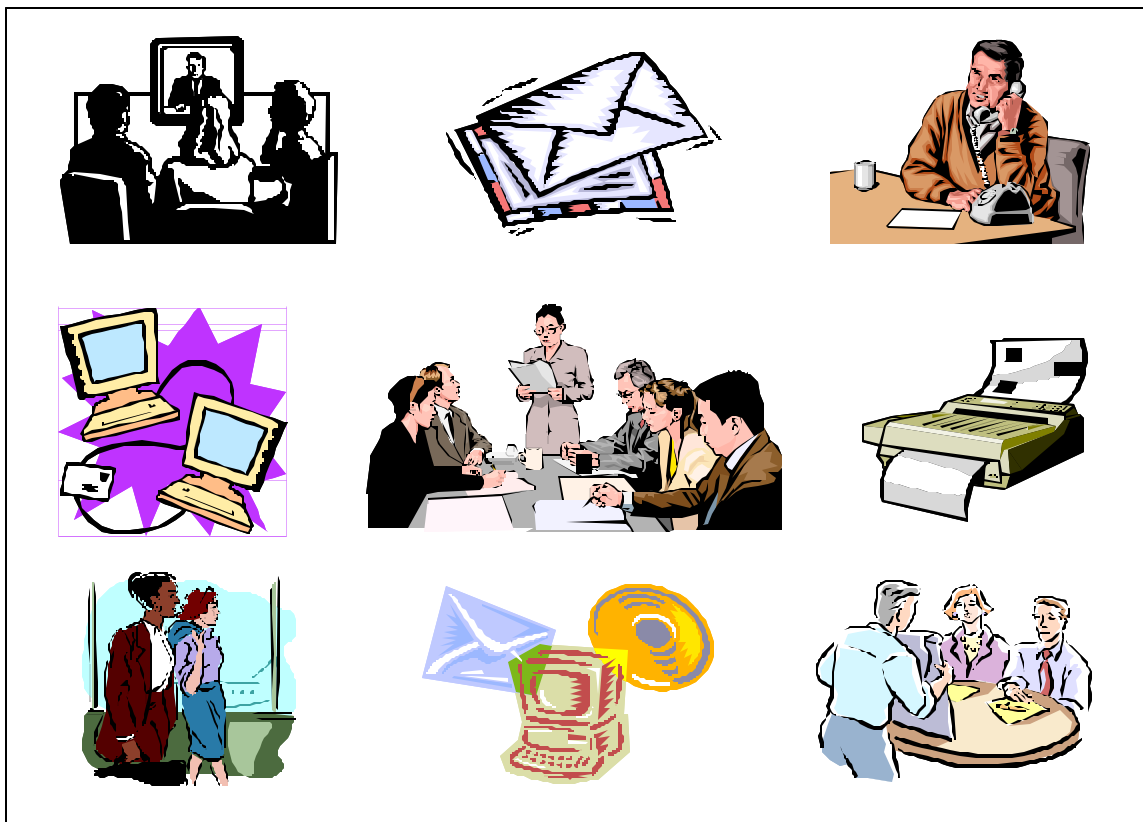


Figure 10. Communications With the Major Range and Test Facility Base

While the telephone is the most important communication tool, it is no substitute for face-to-face meetings. The PMO should work through the Project Engineer to arrange meetings at WSMR. The PMO should invite the widest possible audience to planning meetings. Many test support personnel at WSMR have extensive experience and will offer excellent solutions to problems and alternative approaches, provided that PMO personnel can adequately convey what they want to accomplish in a test. As test-day approaches, PMO personnel should ask the Project Engineer to arrange individual meetings with key technicians who will operate critical instrumentation such as telemetry, optics, and radar. These just-before-test meetings will assure that both parties understand what is planned and that the “Commander’s Intent” is given in case circumstances require real-time deviation from the instrumentation plan.

Managing a major test involving one or more MRTFB installations is one of the most complicated activities conducted anywhere. Extreme care should be exercised to coordinate each aspect of a test with all the participants. The more complicated the test, the more important it is for the PMO to coordinate with all the participants.

C. WHITE SANDS MISSILE RANGE SAFETY AND ENVIRONMENTAL CONSIDERATIONS

The PMO must carefully monitor safety and environmental issues when planning a T&E program at WSMR. Safety and environmental issues should be considered from the earliest stage of test planning. Their impact can range from minor, to very expensive, to irresolvable. Failure to adequately address either safety or environmental concerns can stop a T&E program.

The Environmental and Safety Directorate at WSMR is organized under the Commander, White Sands Test Center, as shown in Figure 4. They provide comprehensive environmental and safety support for all activities on WSMR. [Ref. 10:para. 15-1]

1. Safety Considerations

The WSMR routinely conducts tests of systems presenting hazards such as explosives, fire, kinetic energy, high pressure, high temperature, lasers, radiation, and toxic materials. The WSMR managers take safety very seriously. The PMO must assure

that all aspects of their test program meet WSMR's rigorous safety standards. This can be especially challenging when dealing with flight safety issues. The WSMR safety personnel often adopt an adversarial approach when dealing with customers.

a. Flight Termination System and Safe & Arm

Unmanned flight vehicles, such as missiles, almost always require a Flight Termination System (FTS) and a Safe and Arm (S&A) device. FTSs and S&As must be certified to standards dictated by WSMR flight safety personnel. The PMO personnel have reported that certification is a long, difficult, and expensive process. Once a FTS or S&A has been certified for one application, there is no guarantee it will be approved for a similar application without extensive additional testing. Likewise, a slight change to a FTS or S&A can result in a requirement to re-accomplish the certification test program. Some users have reported significant changes in safety requirements after a change in WSMR safety personnel. The PMO should initiate the certification process for any flight safety component at least one year before the first flight is planned. This can be particularly difficult for a new system to do where program hardware is in extremely short supply. Waivers of FTS or S&A certification requirements are extremely rare.

b. White Sands Missile Range Boundaries

Some modern missiles and targets operate at energy levels, ranges, and altitudes that make it difficult for them to stay within the boundaries of WSMR, even with its extensions. All test vehicle trajectories, target trajectories, intercept debris patterns, and FTS destruct debris patterns must stay within protected boundaries during the entire operation. Encroachment on the White Sands National Monument is not permitted. Only trajectories that meet all these requirements may be flown. In addition, debris patterns from high altitudes intercepts require Federal Aviation Administration (FAA) approval. They may require closure of vast amounts of commercial airspace. FAA approval is difficult to obtain and opportunities for testing may be restricted to a few days per month.

Some T&E programs have encountered significant flight safety restrictions on the trajectories and type operations that WSMR can accommodate. It may be impossible for some programs to test under conditions that accurately simulate tactical engagements. The PMO should make an early assessment of WSMR's ability to

accommodate the desired test parameters. The PMO may determine that another test range, such as those at Kwajalein, Kauai, or Eglin AFB, better suits program requirements.

c. Laser Testing

High-energy laser testing is fairly common at WSMR, particularly at the High Energy Laser Systems Test Facility. Tests must be designed to preclude any possible damage to nonparticipating aircraft and spacecraft. This imposes restrictions on the times and directions in which lasers can be operated. [Ref. 11:p. 6-1]

2. Environmental Considerations

The WSMR commander is the custodian of a unique and fragile ecological system. The PMO must work with WSMR to ensure that all aspects of T&E programs meet WSMR's rigorous environmental standards. The clear trend in recent years is toward more restrictions to protect the environment.

a. Environmental Restrictions

The environment at WSMR is protected by numerous laws, executive orders, regulations, policies, and procedures. In addition, WSMR is home to several endangered species whose habitat must be protected. A partial list of relevant environmental documents includes the

Clean Air Act; Clean Water Act; Safe Drinking Water Act; Toxic Substance Control Act; Insecticide, Fungicide, and Rodenticide Act; National Environmental Policy Act; Asbestos, Radon, and Lead Abatement laws; Noise Abatement laws; Army environmental program management guidance, and other applicable Federal, state, and local environmental laws and regulations. [Ref. 10:para. 15-7]

b. Environmental Concerns

Environmental concerns, like safety concerns, must be addressed by all T&E programs operating at WSMR. The PMO should consider the timeline for obtaining environmental approval when developing T&E schedules. This is particularly important when construction is required. Something as simple as building a dirt road or preparing a test site in the desert could generate significant environmental concerns. For activities involving major construction or tests involving over-flight of areas adjacent to

WSMR (launch at Fort Wingate with impact on WSMR) the environmental approval process could take three years or more.

D. WHITE SANDS MISSILE RANGE SECURITY CONSIDERATIONS

Security is an important aspect of most DoD T&E programs. The PMO must be prepared to conform not only to the security requirements of its parent organization, but also to those of WSMR. On occasion, this may mean operating in non-tactical, more secure modes.

The WSMR routinely handles data and hardware at the Secret and Confidential security classification levels. Operations at the Top Secret security classification level are possible, but require additional planning. Some key WSMR data collection and reduction support contracts do not require their personnel to have Top Secret clearances.

Additional planning is also required if classified test hardware or targets are used. The burden of resolving practical issues related to acquiring, storing, moving, emplacing, maintaining, and flying classified hardware can be significant.

Access to WSMR and many areas on WSMR is strictly controlled. Advanced notification of visits is essential. Some PMO contractor personnel reported having more access problems than Government personnel.

E. TEST AND EVALUATION SCHEDULE

The WSMR normally handles a large number of simultaneous T&E programs. Test resources are limited. DoD Directive 3200.11 states that, “Test resources shall be scheduled on the basis of a priority system that gives equitable consideration to all DoD Components. Use of existing Military Department priority and precedence rating systems is encouraged, but such systems must accommodate DoD priorities, and not discriminate among DoD programs on the basis of DoD Component sponsorship.” [Ref. 2:para. 3.2] In practice, test range scheduling is a dynamic process. It is much more an art than a science. Schedule conflicts are inevitable. However, most users reported that WSMR does a good job with the resources they have to work with.

1. Project Management Office Schedule

The PMO should open T&E planning discussions with WSMR a minimum of one year before the first scheduled test. If complicated tests or construction is anticipated,

planning talks should start earlier. The care and skill with which the PMO develops the T&E schedule can have a significant effect on the overall success of the T&E program.

a. Initial Test and Evaluation Schedule

At the beginning of each development program, the PMO produces an overall schedule. Use of test consultants from WSMR will help ensure that the initial T&E schedule is reasonable. It is usually advisable to initiate planning discussions with WSMR well in advance of the one-year minimum before the first planned test.

b. Maintaining a Reasonable Test and Evaluation Schedule

Normally, the bulk of T&E activities occur toward the end of a development program. As a program progresses, it is not uncommon for a PMO to encounter issues that tend to cause delays. Under great pressure to maintain overall schedule, some PMOs try to compress the T&E portion of the program to regain lost time. This is usually counterproductive. Experience has shown that a test program should be event-driven rather than schedule-driven. T&E programs rarely progress as smoothly as planned. Test delays and unanticipated test results are common. Trying to maintain a compressed, high-risk test schedule is usually a recipe for failure.

2. White Sands Missile Range Schedule

The WSMR develops a complex test range schedule to accommodate the requirements of a wide variety of users. The overall schedule is constantly being reworked as various test programs adjust their individual schedules to account for hardware problems, software problems, weather problems, personnel shortages, power outages, lack of spare parts, lack of test hardware, lack of support hardware, test area evacuations, late engineering analyses, and a host of other problems. The overall test range schedule is a dynamic document.

The Project Engineer and Test Conductor represent the PMO in the test range scheduling process. A good Project Engineer and a good Test Conductor who understand the nuances of the scheduling process and who can successfully negotiate for advantageous test times are tremendous assets to any program.

F. UNIVERSAL DOCUMENTATION SYSTEM

The UDS is a critical element of any T&E program at WSMR. It is incumbent on PMO personnel to clearly and concisely express their test requirements in UDS

documents. The WSMR operators report that PMO personnel often know what they want from a test but have difficulty conveying specific details to WSMR personnel. Effective use of the UDS can greatly reduce the ambiguity.

Information in Chapters 2 and 3 and Appendix D outlines the elements of the UDS. Writing UDS documents for a new program can be a long and arduous process. The PMO personnel often turn to the WSMR Project Engineer for help with the PI and PRD and the Test Conductor for help with the OR. Once the UDS documents have been completed for a test, it is fairly simple to modify them for subsequent tests.

Surprisingly few PMO personnel and contractors have direct contact with the UDS. Many PMO personnel and contractors seem to fail to appreciate the key role of the UDS in the T&E process. Typically, the PMO will designate an individual, either Government or contractor, to be responsible for producing UDS documents. This individual usually receives help from experts in narrow technical areas. If used as intended, the UDS is a primary method for conveying critical requirements to WSMR.

G. TEST AND EVALUATION COST

Conducting a T&E program is expensive. MRTFB support costs are reimbursable by the user. You pay for what you get. The PMO develops a planned T&E budget. The care and skill with which that budget is produced can have a significant effect on the overall success of the T&E program.

1. Budget Planning

At the beginning of each development program, the PMO produces an overall budget. Use of test consultants from WSMR will help ensure a reasonable initial budget for the T&E portion of the program. In addition, the PMO can give the WSMR consultant a budget bottom-line and the consultant can estimate how much testing that will buy.

2. Test Costs

Costs to conduct a major test at WSMR can be significant. There are direct costs for large numbers of support personnel, instrumentation, and data. There may also be significant indirect costs for evacuating and securing safety hazard areas. The PMO starts to incur nonrefundable test range costs well before a test occurs. When a test is scheduled and then cancelled, WSMR charges the PMO according to the scale in Table 3.

[Ref. 12:p. 3-5] The reason for a cancellation is irrelevant; the PMO pays. Likewise, there is no refund for a target that is launched and not used. It does not matter whether or not the interceptor or sensor under test is ever used; the PMO pays. The PMO must budget for a reasonable number of cancelled tests.

Some senior PMO personnel report that they consider the cost of testing at WSMR excessive. They have shifted some T&E activities to other test ranges with lower perceived costs.

| Time Before Test | Scheduled Labor Charge |
|-------------------------|-------------------------------|
| 4 Work Days | 0 |
| 3 Work Days | 10% |
| 2 Work Days | 30% |
| 1 Work Day | 50% |
| Day of Test | 90% |
| Countdown Started | 100% |

Table 3. White Sands Missile Range Test Cancellation Charges [From: Ref. 11:p. 3-5]

H. PROGRAM MANAGEMENT OFFICE TEST AND EVALUATION PREPARATION

There are a number of steps that the PMO can take to avoid common problems during the T&E phase of a development program.

1. Experienced Personnel

Many problems can be avoided by ensuring that the PMO T&E team contains Government and contractor personnel with WSMR experience. The weapon system development community contains a large cadre of professionals with extensive WSMR T&E experience. The PMO should make use of this valuable resource.

2. Test Hardware Readiness

Test hardware should be working and a final test plan should be in-hand before going to WSMR. Technical problems should be corrected and all hardware should be

thoroughly checked-out before it is shipped to WSMR. It is far easier to correct technical problems with the home-base support infrastructure and stockpile of unique spare parts. The WSMR is a poor place to do subsystem engineering.

3. Joint Analysis Team

The PMO should organize a Joint Analysis Team (JAT) to oversee test planning and the data analysis process. The JAT must have high-level representatives from four key organizations: PMO, evaluator, tester, and user. The JAT is normally chaired by the Tester for formal Government tests and by the PMO for non-formal and contractor efforts. The JAT should participate in the planning, execution, and reporting of all test activities. The JAT should consider inputs from all four organizations in determining test results and causes of failures. This results in a more balanced approach than any one organization could produce. By having the JAT agree to objectives before a test and the results after a test, all four organizations can speak with a single voice. To work effectively, the JAT must be established over a sufficiently long period of time so that the members learn to trust each other. The JAT concept has worked well in the past.

I. OTHER TEST CONTRIBUTORS

While WSMR typically provides the bulk of test support, the PMO must often also arrange test support from other agencies. This may include items such as targets, electronic countermeasures (ECM), and unique support equipment. Typical target sources include the Simulation, Training, and Instrumentation Command (STRICOM), the Naval Air Warfare Center, and the Joint Targets Office. Typical ECM sources include the Army Research Laboratory's Survivability/Lethality Analysis Directorate (SLAD), contractors, and the Services. The PMO must coordinate the integration of these other support agencies into the test planning process. The PMO must also budget and fund these other support agencies separately from WSMR.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The DoD has a massive T&E infrastructure. A cooperative, team-oriented approach between PMO and MRTFB personnel is the norm. While some level of conflict and disagreement must be expected, the overall system is working well and is successfully completing the T&E mission for which it was intended.

1. Major Range And Test Facility Base

The MRTFB is a set of major test installations, facilities, and ranges used to support DoD T&E missions. The MRTFB contains advanced and unique facilities and capabilities that make them national assets.

A symbiotic relationship exists between a DoD weapon system PMO and a MRTFB installation or activity. The PMO cannot complete the essential T&E portion of development without test range support. The primary reason the MRTFB exists is to support PMO T&E programs. The PMO and the MRTFB need each other.

2. White Sands Missile Range

The WSMR is an excellent example of a leading MRTFB facility. The WSMR is the largest overland test range in the U.S. It covers approximately 3200 square miles and has lease/partnering agreements that allow it to be expanded to 7100 square miles. It is regularly used by customers from the Army, Navy, and Air Force, as well as other authorized users.

3. Project Engineer and Test Conductor

The Project Engineering system in place at WSMR works very well. The Project Engineer is in the gap between the PMO and WSMR. The Project Engineer has to determine what the PMO really wants from a test and how WSMR can economically fulfill those test requirements. The Project engineer is often the individual with the best understanding of both sides.

It is critical that PMO personnel establish a good working relationship with the Project Engineer and the Test Conductor. Typically, WSMR assigns very capable and experienced personnel to these positions. It is normal for PMO test personnel to develop close, cooperative, working relationships with the Project Engineer and the Test

Conductor. The Project Engineer and the Test Conductor can make or break a T&E program.

Some PMOs with continuing test programs at WSMR have worked with the same Project Engineer and Test Conductor for a number of years. The experience and skill of these personnel have been a major factor in the successful completion of numerous T&E objectives over a period of many years.

4. Communications

Good communications are an essential element of a successful T&E program. Communications must be frank, open, and continuous over the life of the T&E program.

Managing a major test is one of the most complicated activities conducted anywhere. Extreme care should be exercised to coordinate each aspect of a test with all the participants. The more complicated the test, the more important it is for the PMO to coordinate with all the participants. For a major test to be successful, hundreds of people must work together to complete thousands of technically-demanding tasks. The devil is in the details. Good communications are absolutely essential.

5. Safety

The PMO must work with WSMR safety personnel to assure that all aspects of a T&E program meet WSMR's rigorous safety standards. FTS and S&A certification issues are particularly contentious. The certification process can be long and expensive. Waivers of FTS or S&A certification requirements are rare.

Some modern missiles and targets operate at energy levels, ranges, and altitudes that make it difficult for them to stay within the boundaries of WSMR, even with its extensions. The WSMR safety restrictions on trajectories may make it impossible for some programs to test under conditions accurately simulating tactical engagements.

6. Environment

The PMO must work with WSMR environmental personnel to ensure that all aspects of a T&E program meet WSMR's rigorous environmental standards. The clear trend in recent years is toward more restrictions to protect the environment.

7. Security

Security is an important aspect of most DoD T&E programs. The PMO must be prepared to conform not only to the security requirements of its parent organization, but also to those of WSMR. On occasion, this may mean operating in non-tactical modes. Considerable additional planning is required if a T&E program involves Top Secret information. Additional planning is also required if classified test hardware or targets are used. The burden of resolving practical issues related to acquiring, storing, moving, emplacing, maintaining, and flying classified hardware can be significant.

8. Schedule

Test range scheduling is a constant issue at the WSMR. A number of different T&E programs are normally conducted simultaneously using common, limited resources. Schedule conflicts are inevitable. However, most users reported that WSMR does a good job with the resources they have to work with. Having a good Project Engineer and a good Test Conductor to work scheduling issues is critical.

A T&E program should be event-driven rather than schedule-driven. A T&E program rarely progresses as smoothly as planned. Test delays and unanticipated test results are common. Attempts to compress the T&E program are usually counterproductive.

9. Universal Documentation System

The UDS is a critical element of any T&E program at WSMR. If used as intended, the UDS is a primary method for conveying critical requirements information to WSMR. PMO personnel often know what they want from a test but have difficulty conveying specific details. Effective use of the UDS can greatly reduce any ambiguities.

10. Cost

Conducting a T&E program at WSMR is expensive. The WSMR support costs are reimbursable by the user. Some senior PMO personnel consider these costs to be excessive. They have shifted some T&E activities to other MRTFB installations with perceived lower costs.

The PMO starts to incur nonrefundable test range costs well before a test occurs. When a test is scheduled and then cancelled, the PMO pays. Likewise, there is no refund for a target that is launched and not used.

B. RECOMMENDATIONS

1. Director of Testing

The PMO should designate a Director of Testing as the counterpart to the STAD Project Engineer. The Director of Testing should be empowered with the authority to make decisions and commit the PMO to a position.

The PMO Director of Testing must establish and constantly foster a good working relationship among PMO test personnel, the Project Engineer, and the Test Conductor. Having found a good Project Engineer and a good Test Conductor, the Director of Testing should work hard to retain them, often over a period of many years.

2. Communications

The PMO must establish and maintain good communications with WSMR, particularly with the Project Engineer and the Test Conductor. The PMO should invite the widest possible audience to planning meetings. As test-day approaches, PMO personnel should ask the Project Engineer to arrange individual meetings with the key technicians who will operate critical instrumentation. These just-before-test meetings will assure that both parties understand what is planned and the “Commander’s Intent” is given in case circumstances require real-time deviation from the instrumentation plan. The more complicated the test, the more important it is for the PMO to coordinate with all the participants.

3. Safety

Safety personnel at WSMR should improve their customer service. They can accomplish their mission without adopting an adversarial approach in dealings with customers. In addition, WSMR safety personnel should be more consistent in imposing safety requirements on customers. The current situation is untenable where the PMO may receive a new set of safety requirements anytime WSMR safety personnel change. The trend toward more safety restrictions has reached the point where WSMR is no longer a viable location for some T&E programs. Safety personnel at WSMR should find ways to help customers succeed while still maintaining safe operations.

The PMO should make an early assessment of WSMR’s ability to accommodate the desired flight test parameters. This is particularly important for missiles and targets

that operate at energy levels, ranges, and altitudes that make it difficult for them to stay within the boundaries of WSMR.

4. Environment

Environmental personnel at WSMR should also improve their customer service. They can accomplish their mission without adopting an adversarial approach in dealings with customers. The trend toward more environmental restrictions is reaching the point where WSMR is no longer a viable location for some T&E programs. Environmental personnel at WSMR must find ways to help customers succeed while still complying with all applicable laws, executive orders, regulations, policies, and procedures.

5. Planning

The PMO should use WSMR personnel as consultants during the earliest stages of program planning. They can offer unique insights into the feasibility and expense of demonstrating weapon system performance in the T&E environment.

The PMO should initiate detailed T&E planning discussions with WSMR more than one year before the first test is scheduled.

The PMO should begin writing the Program Introduction (PI) at least one year before the first test is scheduled.

The PMO should begin the certification process for flight safety items such as the FTS, telemetry transmitters/receivers, radar beacons, and the S&A at least one year before the first test is scheduled.

For a typical T&E program, the PMO should begin the environmental approval process at least one year before work is scheduled to start on facility construction or one year before the first test, whichever is earliest. For activities involving major construction or tests involving over-flight of areas adjacent to WSMR (launch at Fort Wingate with impact on WSMR) the environmental approval process could take three years or more.

6. Schedule

The PMO should develop an event-driven rather than a schedule-driven T&E program. The PMO's schedule must be flexible enough to accommodate test delays and unanticipated test results, which are a normal part of the T&E process. A compressed T&E schedule is high-risk and should be avoided.

7. Universal Documentation System

The PMO should put significant effort into producing a high-quality PI, Program Requirements Document (PRD), and Operations Requirements (OR). The Director of Testing should ensure that all PMO test team personnel read and understand the UDS documents. The Director of Testing should ensure that UDS documents reflect all significant agreements reached during test-planning meetings with WSMR.

8. Cost

The PMO should budget for test cancellations. Test range costs are essentially the same for a test that is cancelled at the last moment as they are for a test that is completed successfully. Cancelled and rescheduled tests are an unfortunate but real aspect of the test process.

The PMO should evaluate all possible MRTFB options to determine which offers the most cost-effective solution for a test or series of tests.

9. Personnel

The PMO test team should be built around a cadre of Government and contractor personnel with WSMR experience.

10. Test Hardware Readiness

The PMO should ensure that all technical problems have been resolved and all hardware has been thoroughly checked-out before shipping to WSMR. Hardware technical problems should be corrected at home. Artificial program schedule goals do not justify shipping incomplete or under-tested hardware to WSMR.

11. Joint Analysis Team

The PMO should organize a JAT that includes the PMO, the evaluator, the tester, and the user. The JAT should participate in the planning, execution, and reporting of all test activities. The JAT should consider inputs from all four organizations in determining

test results and causes of failures. By having the JAT agree to objectives before a test and the results after a test, all four organizations can speak with a single voice.

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APPENDIX A. ACRONYMS

| | |
|-----------|--|
| AFDTC | Air Force Development Test Center |
| AFFTC | Air Force Flight Test Center |
| AFWTF | Atlantic Fleet Weapons Training Facility |
| ARL | Army Research Laboratory |
| ATC | Aberdeen Test Center |
| ATEC | Army Test and Evaluation Command |
| AVTB | Amphibious Vehicle Test Branch |
| BMC3I | Battle Management, Command, Control, Communications, and Intelligence |
| CCF | Central Control Facility |
| DEMVAL | Demonstration and Validation |
| DDOT&E/RR | Deputy Director, Operational Test and Evaluation/Resources and Ranges |
| DG | Documentation Group |
| DoD | Department of Defense |
| DOT&E | Director, Operational Test and Evaluation |
| DPG | Dugway Proving Ground |
| DT | Development Testing |
| EC | Executive Committee |
| ECM | Electronic Countermeasures |
| EMD | Engineering and Manufacturing Development |
| FAA | Federal Aviation Administration |
| FTS | Flight Termination System |
| HEDI | High Endoatmospheric Defense Interceptor |
| HELSTF | High Energy Laser Systems Test Facility |
| IMA | Intermediate Maintenance Activities |
| JAT | Joint Analysis Team |
| JITC | Joint Interoperability Test Command |
| KMR | Kwajalein Missile Range |

| | |
|----------|---|
| MDAP | Major Defense Acquisition Program |
| MILCON | Military Construction |
| MRTFB | Major Range and Test Facility Base |
| NAWCAD | Naval Air Warfare Center - Aircraft Division |
| NAWCWPNS | Naval Air Warfare Center Weapons Division |
| OD | Operations Directive |
| OO-ALC | Ogden Air Logistics Center |
| OR | Operations Requirements |
| ORD | Operational Requirements Document |
| ORE | Operation Requirements Extract |
| OT | Operational Testing |
| PACM | PATRIOT Anti-cruise Missile |
| PI | Program Introduction |
| PMO | Project Management Office |
| PRD | Program Requirements Document |
| PRDE | Program Requirements Document Extract |
| PSP | Program Support Plan |
| RCC | Range Commanders Council or Range Control Center |
| ROM | Rough Order of Magnitude |
| RTO | Responsible Test Organization |
| S&A | Safe and Arm |
| SC | Statement of Capability |
| SFTC | Single Face To the Customer |
| SLAD | Survivability/Lethality Analysis Directorate |
| SPO | System Program Office |
| STRICOM | Simulation, Training, and Instrumentation Command |
| STAD | System Test and Assessment Directorate |
| TAMD | Theater Air and Missile Defense |
| TEMA | Test and Evaluation Management Agency |
| T&E | Test and Evaluation |
| THAAD | Theater High Altitude Area Defense |

| | |
|-----------|---|
| TW | Test Wing |
| UDS | Universal Documentation System |
| U.S. | United States |
| USAEPG | U.S. Army Electronic Proving Ground |
| USAKA | U.S. Army Kwajalein Atoll |
| USD(AT&L) | Under Secretary of Defense for Acquisition, Technology, and Logistics |
| UTTR | Utah Test and Training Range |
| WSMR | White Sands Missile Range |
| YPG | Yuma Proving Ground |

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APPENDIX B. INTERVIEW SOURCES

A. WHITE SANDS MISSILE RANGE USERS

Mike Alvarez

Job Title: Vice-President, Test and Evaluation

Organization: Miltec Corporation (CAS Incorporated supporting PATRIOT Project Office at time of testing.)

Name of the test program: PATRIOT

Approximate dates of WSMR testing: 1992-1998

Location of WSMR testing: LC-38, Mine Site, Self Site

Type testing: Weapon system Technology Demonstration and Development tests. Missile flight-testing, ground testing, launcher testing, and radar testing.

Approximate size of test program: Numerous missile flight tests and ground tests.

Robert J. DeRosa

Job Title: Program Manager

Organization: Raytheon

Name of the test program: PATRIOT

Approximate dates of WSMR testing: 1970's - 1999

Location of WSMR testing: LC-38, North Range, and Ortho Site

Type testing: Weapon system Technology Demonstration and Development tests. Missile flight-testing and seeker ground-to-ground and ground-to-air testing.

Approximate size of test program: Large numbers of PATRIOT missile flight tests.

William Evans

Job Title: Office Manager, Tactical Missile Department

Organization: CAS Incorporated (Retired government employee)

Name of the test program: PATRIOT, MAULER

Approximate dates of WSMR testing: 1963 - 1999

Location of WSMR testing: LC-38, LC-34, North Range, Ortho Site, Holloman AFB

Type testing: Weapon system Technology Demonstration Testing, Development Testing, Operational Testing, and Production Verification Testing. Seeker ground-to-ground, ground-to-air, and captive carry testing, missile flight-testing, and radar testing.

Approximate size of test programs: Large numbers of PATRIOT and MAULER missile flight tests and radar tests.

Tom Hamilton

Job Title: Data Analyst

Organization: Schafer Corporation (Lockheed Martin Missiles and Space Company at time of testing)

Name of the test program: THAAD

Approximate dates of WSMR testing: 1995-1998

Location of WSMR testing: LC-36

Type testing: Demonstration and Validation (DEMVAL) missile flight-testing

Approximate size of test program: Four flight tests

Larry Haynes

Job Title: Data Analyst

Organization: Schafer Corporation (Lockheed Martin Missiles and Space Company at time of testing)

Name of the test program: THAAD

Approximate dates of WSMR testing: 1995-1998

Location of WSMR testing: LC-36

Type testing: DEMVAL missile flight-testing

Approximate size of test program: Eight flight tests

Colin W. Lees

Job Title: Lead Engineer for Testing

Organization: USASMDC, Office of Technical Integration and Interoperability
(Weapons Directorate and HEDI Project Office at time of testing.)

Names of the test programs: PATRIOT Anti-cruise Missile (PACM); High
Endoatmospheric Defense Interceptor (HEDI)

Approximate dates of WSMR testing: PACM 1997-1999, HEDI 1991-1992

Location of WSMR testing: PACM - LC-38, LC-50, North Range, Ortho Site;
HEDI - LC-38

Type testing: PACM – Technology Demonstration missile flight-testing, seeker
ground-to-ground and ground-to-air testing; HEDI - Technology Demonstration
missile flight-testing, seeker ground-to air testing

Approximate size of test program: PACM - Two flight tests and ground tests;
HEDI - One flight test and ground tests

Larry E. Moore

Job Title: Technical Director

Organization: Lower Tier Project Office

Name of the test program: PATRIOT

Approximate dates of WSMR testing: 1978 - 2001

Location of WSMR testing: LC-38, Norma Site, Dog Site, Rampart Site, C
Station, other Up-Range sites.

Type testing: Missile flight, ground, launcher, and radar testing associated with
Program Definition and Risk Reduction, Engineering and Manufacturing
Development, Operational Testing (OT), OT Follow-on Testing, Production
Verification, System Surveillance and Guidance, Post Deployment Build
software, and other weapon system upgrades.

Approximate size of test programs: Massive test program using dedicated test
facilities over many years. Major weapon system development, fielding,
sustainment, and upgrade testing.

Victor Robbins

Job Title: Senior Engineer

Organization: CAS Incorporated

Name of the test programs: PATRIOT, SENTINEL

Approximate dates of WSMR testing: 1980 - 2001

Location of WSMR testing: LC-38, North Range, EC-30, Ortho Site, Dog Site, Rampart Site

Type testing: Technology Demonstration missile flight-testing, seeker ground-to-ground and ground-to-air testing and radar testing

Approximate size of test programs: Over ten missile flight tests, extensive radar test programs, and numerous seeker ground-to-ground and ground-to-air tests

Herbert M. Sanborn

Job Title: Program Manager

Organization: Raytheon

Name of the test program: PATRIOT, THAAD

Approximate dates of WSMR testing: 1975 - 1999

Location of WSMR testing: LC-38, R-402, North Range, Small Missile Range

Type testing: Weapon system Technology Demonstration and Development tests. Missile flight-testing and radar testing

Approximate size of test programs: Large numbers of missile flight tests and radar tests.

Ronald Smith

Job Title: Lead Engineer for Testing

Organization: USASMDC, Systems Directorate (Weapons Directorate at time of testing)

Name of the test program: Nautilus

Approximate date of WSMR testing: 1997

Location of WSMR testing: High Energy Laser Systems Test Facility (HELSTF)

Type testing: Technology Demonstration laser testing

Approximate size of test program: Ground-based laser firing against 155 mm artillery shell and 122 mm rocket targets.

Phillip Terry

Job Title: Test Engineer

Organization: Miltec Corporation (Coleman Research Corporation at time of testing)

Name of the test program: THAAD; HEDI

Approximate date of WSMR testing: THAAD – 1993-1999; HEDI – 1991 - 1992

Location of WSMR testing: LC-36

Type testing: THAAD – DEMVAL missile flight-testing; HEDI – Technology Demonstration missile flight-testing.

Approximate size of test program: THAAD – 11 flight tests; HEDI – 3 flight tests.

B. WHITE SANDS MISSILE RANGE OPERATORS

Joaquin Castro

Job Title: Assistant Project Engineer

WSMR Organization: NCI, SETA to STAD

Approximate years of National Test Range experience: 12

Typical test program: Weapon system development from concept definition to operational testing to system upgrade. Flight-testing, radar testing, and seeker ground-to-air testing.

Angela Delgado

Job Title: Chief, PATRIOT Test Operations Section

WSMR Organization: System Test and Assessment Directorate

Approximate years of National Test Range experience: 27

Typical test program: Development testing of surface-to-air missile.

Dan Hicks

Job Title: Chief, Space Sensors and Interoperability Branch

WSMR Organization: System Test and Assessment Directorate

Approximate years of National Test Range experience: 19

Typical test program: Development testing in the areas of surface-to-air missiles, air-to-air missiles, air-to-surface ordinance, and artillery programs for the Army, Navy, and Air Force.

David Ribail

Job Title: Project Engineer

WSMR Organization: System Test and Assessment Directorate

Approximate years of National Test Range experience: 15

Typical test programs: Development testing in the areas of surface-to-air missiles (PATRIOT, HAWK), ground forces (M1A1, M1A2), and aircraft (JSTARS)

APPENDIX C. INTERVIEW COMMENTS

A. WHITE SANDS MISSILE RANGE USERS

1. Description of Interface With White Sands Missile Range

- a. Direct interface with WSMR/STAD at Branch Chief level. Also, direct interface with WSMR/STAD Project Engineer and Test Conductor. Interfaced with other WSMR organizations when arranged by WSMR/STAD.
- b. Interfaced directly with WSMR/MTD (now WSMR/STAD) Project Engineer. Interfaced directly with ARL/SLAD for test support. Interfaced directly with target suppliers. Interfaced with National Range and WSMR test support contractors, when arranged by WSMR/MTD (now WSMR/STAD) Project Engineer
- c. Interfaced directly with WSMR/MTD Project Engineer. Occasional direct interface with other WSMR organizations, when arranged by WSMR/MTD (now WSMR/STAD) Project Engineer.
- d. Interface was through the WSMR/MTD (now WSMR/STAD) Project Engineer who coordinated test activities with the National Range.
- e. Interface was through the Project Management Office (PMO) test organization to the WSMR/MTD (now WSMR/STAD) Project Engineer.
- f. Interface was usually through the government sponsor. Interfaced directly with WSMR/MTD (now WSMR/STAD) on occasion. Occasionally interfaced directly with test conductor. The interface requirements were driven by each individual test program.
- g. Interfaced primarily with prime contractor's permanent test team at WSMR. Interfaced directly with WSMR/MTD (now WSMR/STAD) Project Engineer. Occasional direct interface with other WSMR organizations, when arranged by WSMR/MTD (now WSMR/STAD) Project Engineer.

- h. Interfaced primarily with prime contractor's permanent test team at WSMR. Some direct contact with WSMR/MTD (now WSMR/STAD) Project Engineer.
- i. Interface was through the PMO test organization. Data were collected using BMC3I hardware supplied by the PMO.
- j. Developed personal relationships with WSMR personnel over the years. This greatly facilitated working relationship.
- k. Coordination of test activities with WSMR was mostly handled by a tenant facility on WSMR. Coordinated photographic support with WSMR. Coordinated test safety issues with WSMR related to possible impact of laser firing on people on WSMR and aircraft operating over and near WSMR.

2. Description of Interface With the Universal Documentation System

- a. Wrote Program Introduction (PI) and Operations Requirements (OR) documents for the PMO. Used essentially same OR with minor modifications on several flight tests. Straightforward process.
- b. Supported missile prime contractor in writing PI and OR documents. Supported writing environmental impact documentation.
- c. Provided input to prime contractor's permanent test team at WSMR. They handled UDS.
- d. Prime contractor modified old UDS documentation for new program. Reviewed documentation and submitted it to WSMR/MTD (now WSMR/STAD).
- e. Little interface with UDS. Not part of job as a government support contractor. UDS was not used when conducting test programs many years ago.
- f. None. Interface was handled by the PMO test organization.

3. Description of Significant Issues or Problems With White Sands Missile Range

a. Test scheduling is an issue because there are always a large number of different programs testing at WSMR at any time. The WSMR/MTD (now WSMR/STAD) worked hard to minimize schedule conflict.

b. Customers often have more requirements than the test range has assets to accommodate. The WSMR is asset-poor in program-unique and some critical test hardware. Program-unique hardware for many tests had to be obtained from Fort Bliss. The government sometimes has to act as the coordinator between different divisions of a company. Internal conflicts between different divisions of a company led to poor coordination that jeopardized the test activity.

c. Scheduling and priority for using test assets were a constant problem due to heavy demand by other programs. The WSMR Safety Office required excessive environmental testing of missile digital subsystem, which was part of the range safety destruct package. Reducing Top Secret data was a problem because WSMR support contracts did not require their personnel to have Top Secret security clearances. When a new missile telemetry kit was required late in the program, WSMR/MTD (now WSMR/STAD) facilitated bringing prototype hardware to WSMR for verification testing by WSMR support contractors.

d. Test scheduling is an issue because there are always a large number of different programs testing at WSMR at any time and some programs have higher priorities than others. This situation is the same at any National Range. The WSMR/MTD (now WSMR/STAD) worked hard to help programs succeed.

e. The WSMR/STAD grade structure is too low for the Test Conductor on at least one major program. A GS-13 grade is too low for this level of responsibility. (Support from the current and previous Test Conductors has been absolutely invaluable to this Major Defense

Acquisition Program (MDAP). Much of the test program success was due to the excellent work of the WSMR/STAD Test Conductors.) The wrong person in a key test position can create major problems for a program. This has happened on one occasion and was ultimately resolved by WSMR. This individual viewed his role as being a totally independent tester and ignored his support role to the PMO. A balanced role was appropriate at that time. Fortunately, this situation was very unusual and the PMO has enjoyed a good working relationship and good support from the great majority of WSMR personnel. Loss of military operators and maintainers from Fort Bliss hurt the test program. These highly-skilled soldiers maintained and operated the weapon system for testing at WSMR. They were withdrawn by the Army and new civilian personnel had to be brought in as replacements. This produced added cost, delays, and test problems as the new personnel were trained to maintain and operate a highly-sophisticated weapon system. This was not a WSMR problem, but it caused problems at WSMR. If a program can afford to station military personnel at WSMR to operate and maintain equipment, it can greatly facilitate operations and provide valuable experience to the military personnel. They get to work closely with contractor experts. However, a program has to be in continuous testing over a long period to justify this.

f. The missile Flight Termination System (FTS) was a potential showstopper. The original plan was for the Engineering and Manufacturing Development (EMD) missile to use the same FTS that had been used successfully on Technology Demonstration missile flight tests. However, WSMR personnel changed and the new safety personnel required additional work before approving a modified FTS design. Building test facilities on WSMR took longer than expected. The PMO managed the Ballistic Missile Defense Office funded Military Construction (MILCON) project. The WSMR was in a support role. Completion of the environmental assessment was more difficult than planned and there were funding issues.

g. The PMO had an aggressive missile flight test data reduction timeline that WSMR initially could not meet. A teaming arrangement was developed where WSMR and Project analysts worked together to generate the required data reports on the PMO schedule. Flexibility by both organizations was required to fix this problem. The Project initially used range radars as surrogates for the Project radar. The integration of the range radars through the PMO BMC3I hardware took 4 - 6 months, much longer than the original schedule. Modification of software and development of new software to adapt the Project to WSMR constraints was a schedule driver. The missile's range and high intercept altitude made it difficult to operate within the boundaries of WSMR. This produced a very tight intercept box. The missile's high altitude intercept created a daunting debris footprint problem. It took three months to get Federal Aviation Administration (FAA) approval for the high altitude debris pattern produced by an exoatmospheric intercept. An intercept caused air traffic at El Paso International Airport to be stopped for an hour.

h. There were significant problems scheduling test dates and launch times. The PMO would give the WSMR/MTD (now WSMR/STAD) Project Engineer a list of desired test dates. This began an iterative process of scheduling a test date that was acceptable to both the PMO and WSMR. The Project's high national priority did not assure that the test date requested would be scheduled. The weather forecast could not accurately predict if winds would be below test limits. The WSMR required that some operations be made non-tactical due to safety and security concerns. This included encryption of some unclassified data links and a hard-wire instead of a microwave data link to the launcher. The missile's range and high intercept altitude made it difficult to operate within the boundaries of WSMR. This produced a very tight intercept box. Special software had to be written to perform a real-time debris footprint calculation to assure no debris would land on the White Sands

National Monument. This resulted in scrubbed tests where the interceptor countdown was stopped after the ballistic missile target was launched. Personnel support facilities at many test sites were limited, particularly dining facilities. There was a perception that it was more expensive to test at WSMR than at Kwajalein Missile Range.

i. Contractor access to WSMR facilities was a constant aggravation. Visiting government personnel have much freer access than visiting contractor personnel. There were occasional issues with access to data, but the WSMR/MTD (now WSMR/STAD) Project Engineer usually corrected them quickly.

4. Identification of Lessons-learned

a. Test planning discussions with WSMR should be opened at least one year prior to the first test activity. Preparation of UDS user documents should start at least one year prior to the first scheduled test activity. Modification to any test site is a slow process, therefore allow sufficient time. Go with WSMR/MTD (now WSMR/STAD) personnel when they have significant meetings with other organizations critical to your test, such as the National Range, Safety, Environmental, and WSMR support contractors. Invite all these people to your testing planning meetings. Travel to WSMR frequently when planning a test. Visit and inspect all proposed test sites. The user must play a major role in integrating non-WSMR test assets such as electronic countermeasures from Survivability/Lethality Analysis Directorate (SLAD) and targets from STRICOM. Test delays are inevitable due to problems with targets, test equipment, weather (caused power outage), financial "red-tape," competing programs, etc. Perhaps the most important lesson-learned was to establish a "sound" working relationship with WSMR/MTD (now WSMR/STAD), or their equivalent at other Ranges. As an example, WSMR/MDT (now WSMR/STAD) would arrange for early separate meetings with the National Range scheduling personnel to argue privately

for adequate test times and dates. This helped ensure the Project was on the Master Test Schedule when it was drawn up, including back-up dates.

b. Test planning discussions with WSMR should be opened at least one year prior to the first test activity. The WSMR safety constraints place limits on test realism. Attempting to conduct an exoatmospheric intercept test program within the constraints imposed by WSMR boundaries may result in a poor return on investment. There are seasons when relatively benign weather is unlikely at WSMR. User equipment brought to WSMR must conform to WSMR security requirements. There will be no flight test until the WSMR Safety Office is satisfied with the safety-destruct systems on both the missile and the target. The safety-destruct system must break the air-vehicle into pieces.

c. Early coordination of test activities at WSMR is essential. The debris hazard analysis should be started early. The FAA allowed only a certain number of PATRIOT and the Theater High Altitude Area Defense (THAAD) high-altitude intercept flight tests each month. Intercept tests had to be coordinated between PATRIOT and THAAD to stay within the FAA quota.

d. Test planning must start early. A significant amount of coordination activity is required. Requirements must be submitted to WSMR well before support is needed. The WSMR is a busy test facility and you must get your test program on the schedule early.

e. It is essential to work closely with the WSMR/MTD (now WSMR/STAD) Project Engineer. Coordination is key. Coordinate test activities with all concerned parties.

f. The quality of the WSMR/MTD (now WSMR/STAD) Project Engineer had a lot to do with the quality of the test program. An energetic, capable WSMR/MTD (now WSMR/STAD) Project Engineer with good contacts and a good working relationship across various WSMR organizations was critical for a successful test program. Over-land testing provided the possibility of recovering and analyzing critical missile

components after a flight failure. This was essential to determining the cause of a flight failure. There was a steep learning curve in the missile flight test series. Each successive flight test became easier to execute. The WSMR was very cooperative in providing and modifying test facilities, provided the user was willing to pay. Once the National Range was scheduled for a test, the PMO was liable for all costs. The WSMR used a graduated scale for National Range charges in the event of a test cancellation. By the day of test, the charge was the same whether or not there was a test. The reason for a cancellation did not matter, the user paid. The PMO budget must contain a contingency fund for cancelled tests.

g. The WSMR has been an essential link in weapon system fielding and every major upgrade. Laboratory environments and simulations are good for early development and other key aspects of system testing. However, eventually the system must be put in a real environment to confirm total system operations in a field environment. In addition, it is necessary to conduct flight-testing, search/track testing, interoperability testing, and guidance testing where real clutter, multi-path, and active and passive countermeasures can be tested outside of the laboratory environment. The WSMR has been invaluable for these kinds of activities. The continuity gained by having the same WSMR personnel support continuing test programs over many years has been a great asset. Some WSMR personnel have become experts on the weapon system and its operation. This has been particularly true of Test Conductors, who have been critical to successful testing. Use of environmental test facilities at WSMR has been helpful in conducting system-level hot and cold temperature tests. Test operations at WSMR can be expensive. Consideration of alternate test sites may be appropriate if test activities can be satisfactorily conducted at those locations. However, a program must ensure that the alternate site can provide the necessary support. The WSMR/STAD has a good arrangement with the New Mexico Air National

Guard to supply F-16s as targets for radar testing. It was much less expensive to use the Air National Guard F-16s than to have the Air Force or Navy bring in dedicated test support aircraft. The WSMR/STAD can, on occasion, act as an honest broker among the PMO, the DT community, and the OT community. This was particularly useful when WSMR personnel had an in-depth knowledge of the weapon system and no ax to grind with the PMO. The OT community often considered WSMR personnel less biased than PMO personnel and tended to give credence to what they say about a system, particularly when WSMR personnel had demonstrated a system expertise that OT personnel lacked. However, there were problems when WSMR personnel were supporting both the OT community and the PMO at the same time. Having the right people in the right jobs was key to program success.

h. Arrive at WSMR with a reasonable test schedule. Because the T&E phase tends to come at the end of a long development cycle, some programs make the mistake of trying to make-up for earlier schedule slips by compressing the test program. Testing never goes as smoothly as planned. The schedule must be flexible enough to account for unexpected events. A program should arrive at WSMR with all the hardware checked-out and ready to test.

i. The JAT concept has worked well. The JAT had high-level representation from the PMO, evaluator, and test range, including their support contractors. The JAT considered the input from all these organizations in determining test results and causes of failures. This resulted in a more balanced approach than any one organization could have produced. To work effectively, the JAT must be established over a sufficiently long period of time so that the members learn to trust each other. By having the JAT agree to objectives before a test and the results after a test, all three organizations can speak with a single voice. Extreme care should be given to coordinating each aspect of a test with all the participants. The more complicated the test, the more important it was for

the PMO to coordinate with all the participants. In many cases, the PMO was responsible for test support items such as targets, electronic countermeasures, aircraft, user-supplied test equipment, etc. A major test is very expensive to conduct and the PMO has to get it right the first time. It was critical that dry runs be completed with surrogates before the actual test. This included multiple ground-to-air seeker tests with a manned aircraft or drone before an intercept flight test. The cost for multiple dry runs was far less than that of having to repeat a flight test.

j. Do your homework before coming to WSMR. Have a good test plan and good documentation before leaving home. Correct technical problems and thoroughly checkout and test (to the greatest extent possible) all hardware before shipping it to WSMR. The WSMR is the wrong place to do subsystem engineering. There is always a lot of activity on WSMR and schedule conflicts are inevitable. Previous WSMR experience is very valuable for avoiding problems.

k. Personnel participating in test activities should dress appropriately for desert temperature swings. Test support personnel frequently began work around midnight on test day. Nighttime temperatures at WSMR are significantly cooler than during the day.

B. WHITE SANDS MISSILE RANGE OPERATORS

1. Description of Interface With Customer

a. Interface directly with PMO personnel. Primary counterpart was usually the PMO Director of Systems Engineering or Test Director. Frequently interfaced with multiple PMO personnel on large projects. Provided test expertise. Interface could begin as a consultant as early as Operational Requirements Document (ORD) development. Worked with the PMO to develop system procedures, manuals, and environmental analyses. Worked with the PMO to write test plans and then conduct the tests. This included developing tests and procedures that do not require WSMR direct support.

- b. Interface directly with PMO engineers. Interfaced with multiple PMO personnel on a large project. Served as the user's single point-of-contact with WSMR. Determined which WSMR support elements were needed to meet user requirements. Developed user cost estimates.
- c. Interface directly with PMO engineers. Assisted the WSMR/STAD Project Engineer as the user's single point-of-contact with WSMR.
- d. Interface directly with customers. Initially, in a support role with the WSMR/STAD Project Engineer for customer interface. This role reversed in the period leading up to the test. Provided primary customer interface with WSMR by test day.

2. Description of Interface With the Universal Documentation System

- a. The interface started with the Test and Evaluation Master Plan. Advised the PMO on how test objectives can be translated into UDS documentation. Worked with the PMO to develop the Program Introduction and with the National Range to develop the Statement of Capability. Continued to work with the PMO and the National Range to develop subsequent UDS documentation.
- b. Worked with user to write UDS documentation. Worked with National Range Engineer to write UDS documentation. Worked with user and National Range to write an OR document that captured user test requirements within WSMR test support capabilities. Worked with National Range to write Operations Directive that fulfilled user requirements. Reviewed WSMR support element test plans to ensure they meet requirements for optics, telemetry, flight safety, etc.
- c. Helped user write UDS documentation. Often ended up providing much of the user UDS inputs. Know what is available at WSMR, so know what the user should request in UDS documents.
- d. Worked with the PMO to develop UDS documentation. Often ended up writing much of the customer UDS documents.

3. Description of Significant Issues or Problems With Customers

a. Issues often arose when several different test programs had to share the same resources such as manpower, radars, and optical tracking mounts. Test scheduling must be negotiated to accommodate the various programs that are ongoing simultaneously at WSMR. Developmental programs typically produce unique test hardware and test support hardware and software. Delays in user delivery of developmental hardware to WSMR often delayed the test program. User funding may be an issue. There have been technical issues between WSMR and the user concerning how to calculate miss distances for intercept tests. Obtaining flight safety and environmental approval was always an issue. Restrictions designed to protect and preserve the environment are becoming more restrictive on testing.

b. Developmental programs that are schedule-driven instead of event-driven often guarantee themselves testing problems. Their test schedules are often inflexible and unreasonable for a developmental program. Program test cost estimates developed by the PMO without WSMR input frequently involved bad assumptions and resulted in an inadequately funded test program. Contractor overruns that are addressed by cutting testing could result in failure to meet critical test objectives.

c. Problems arose when the customer failed to give WSMR an early, full account of test requirements. Failure to coordinate changes was a big problem. Problems arose when the customer fails to rapidly coordinate requirement changes with WSMR. The WSMR needs to become more accommodating of customer needs and changes in needs.

d. Customers usually know what they desire from a test, but do not know how to go about getting it. Typically, customers are weak in "operations." They often underestimate the level of effort that will be required. The process of the customer clarifying or changing requirements can result in a mission repeat.

4. Identification of Lessons-learned

a. The PMO should contact the test range at the beginning of the acquisition process. The test range should be a consultant to the PMO during system specification development and writing the prime contract scope of work. Test range input will assist the PMO in defining an adequate test program and allow allocation of appropriate funding from program inception. There are usually four major participant organizations in most test programs: developer, evaluator, tester, and user. The PMO should organize a JAT consisting of members throughout the test community with high-level representation from the four key organizations. The JAT is normally chaired by the Tester for formal government tests and by the Developer for non-formal and contractor efforts. The JAT should participate in the planning, execution, and reporting of all test activities. By having the JAT agree to objectives before a test and the results after a test, all four organizations can speak with a single voice.

b. An acquisition program should get the test range involved early in the development cycle. If an acquisition program develops its initial test requirements without test range involvement, a significant revision will likely be required later. Getting the various Services to agree on a schedule for making assets available for a Joint test program has proven difficult. Start early on certification of a missile's safe and arm (S&A) and flight termination system. Recertification of a previously certified S&A or FTS is fairly straightforward. However, certification of a new design is a long, complicated, and expensive process. Waivers for the certification for a new S&A or FTS are extremely rare. Environmental impact must be considered during test planning. Using the same test site and general test parameters from a previous test does not assure environmental compliance. Variations in test parameters or flight profiles can create an adverse environmental impact. The potential environmental impact of each proposed test must be evaluated.

- c. Good communications with WSMR are critical when mutually agreeing to test requirements. The WSMR can help the customer spend their test money wisely, provided the customer gives WSMR insight to their test budget. The WSMR can manage a test program to fit the customer's budget. The WSMR can help the customer save money by suggesting test alternatives, provided the customer tells WSMR their absolute minimum test requirements. Over-specification of test requirements is expensive.
- d. The customer should include STAD Test Operations personnel in initial test planning meetings. A clear articulation of the details of test requirements is critical to getting the results the customer wants.

APPENDIX D. EXCERPTS FROM RANGE COMMANDERS COUNCIL DOCUMENT 501-97, *UNIVERSAL DOCUMENTATION SYSTEM*

[Ref. 7]

1. INTRODUCTION

1.1 General

This handbook describes the Universal Documentation System (UDS). The UDS is used to formally document requesting agency program support requirements and support agency capabilities and commitments to support those requirements.

A complete list of Range Commanders Council (RCC) documents pertaining to the UDS and to other documents can be found in the List of Available Documents and copies can be provided through the RCC Secretariat at the address stated in the preface.

1.2 Applicability

The UDS is expected to be used by all agencies desiring support from RCC member ranges that have adopted the UDS. Requesting agency requirements documents and support agency response documents will be prepared in accordance with the format and procedures in this handbook and with those supplemental instructions prepared by the support agencies.

1.3 Authority

The Documentation Group (DG) of the RCC has the responsibility for design and control of the UDS. The UDS and the procedures contained in this handbook have been approved by the RCC.

1.4 Handbook Revision

Recommendations for revision of this handbook must be made to the DG. Such recommendations must include the reason for the change, deletion, or addition and a sample of the change with its instructions. The DG will review the recommendation, and upon approval, will incorporate these changes. At the discretion of the DG, approval of recommended changes will be deferred to the RCC Executive Committee (EC).

1.5 Definitions

Frequently used terms in this handbook are defined as follows:

Range/Support Agency. An operational facility that provides support services to qualified users as determined by current directives. The words "range," "center," and "support agency" are used interchangeably.

User/Requesting Agency. Any United States or foreign government agency, industrial organization, or other institution with authority to use range or support agency resources.

Sponsor. Any element of a government, military, or civilian agency with authority to use range or support agency resources.

User Requirement. Any item of support stated by a requesting agency through the UDS.

Requestor/Supplier Code. An element of UDS formats (see subparagraph 2.9.3) as identified in appendix A - Designation for UDS Subscriber Agencies of this handbook.

Interagency Program. The participation of more than one range or support agency in a program.

Lead Range/Lead Support Agency. Responsible range/support agency for coordinating total support planning and operations for a particular program, mission, or test. The lead range/lead support agency identifies the support required from other agencies and coordinates the total support effort.

1.6 Information and Assistance Sources

Prospective users of range/support agency services may obtain assistance in the preparation of requirements documentation from the agencies listed below:

See unabridged Document 501-97 for list of agencies.

2. ORGANIZATION AND STRUCTURE

2.1 Purpose

The UDS provides a common language and format for stating requirements and for preparing support responses. The UDS encompasses documentation generated by user agencies which states program, mission, or test requirements and those response documents generated by the support agencies to define the support to be provided.

2.2 Objectives

The UDS objectives are

- ? to establish a common language and format to provide more effective communication between the user and support agency,

- ? to standardize requirement and support methodology between the user and the support agency which achieves an effective planning/performance interface, and

- ? to provide a standard yet flexible and dynamic system that meets the requirement and support needs of both simple and complex programs.

2.3 Concept

The UDS is intended to establish standardization, yet be flexible enough to be used by a number of different agencies. This flexibility permits individual instructions to be prepared by each support agency for implementation of the UDS at that agency. These instructions can contain specific procedures for the scope, submission, and revision of documentation.

2.4 System Criteria

The UDS is based on a common structure that enables users to employ one basic format when presenting requirements to support agencies. This structure is defined in a document outline that combines related subjects of the various program, mission, or test phases into broad categories for simplicity and ease of understanding. This system identifies the necessary information that should pass between the user and all contributing agencies that support the program, mission, or test.

2.5 Document Organization

The UDS Handbook describes three levels of user and support agency documentation:

| LEVEL | REQUIREMENTS DOCUMENT | RESPONSE DOCUMENT |
|-------|-------------------------------------|------------------------------|
| 1 | Program Introduction (PI) | Statement of Capability (SC) |
| 2 | Program Requirements Document (PRD) | Program Support Plan (PSP) |
| 3 | Operation Requirements (OR) | Operations Directive (OD) |

Table 4. Levels of User and Support Agency Documentation

Level 1 documents (the PI and SC) are used to initiate program support planning between users and support agencies.

Level 2 documents (PRD and PSP) are used to provide additional or more detailed program information with specific application to the more complex programs.

Level 3 documents (OR and OD) are used to request and plan support for specific test operations within an all-encompassing program.

2.5.1 Level 1 Documents

Program Introduction (PI). The PI is the initial planning document submitted by a user to the support agency immediately on identification of the scope and duration of a program activity. The user should submit the PI using the best available information, enabling the support agency to initiate resource and technical planning. This information, while sometimes fragmentary and incomplete, is of substantial value to the support agency in determining the scope of the program. For many programs, the PI will eliminate further documentation except for conducting specific operations.

Statement of Capability (SC). The SC is the support agency's response to the PI. When properly signed, the SC is evidence that a program has been accepted for support by the support agency. Support conditions, qualifications, and resources, or other considerations are initially identified in this document, which serves as a baseline reference for subsequent acceptance and commitment by the support agency.

2.5.2 Level 2 Documents

Program Requirements Document (PRD). The PRD is prepared by the range user and is a detailed program planning document required for complex or long lead-time programs.

Program Support Plan (PSP). The PSP is a response to the requirements presented in the PRD and is prepared by the responsible support agency.

2.5.3 Level 3 Documents

Operations Requirements (OR). The OR is a detailed description of the program's requirements for each specific test or series of tests. It is prepared by the user.

Operation Directive (OD). The OD is the support agency's response to an OR and is the detailed plan for implementation of support for a program, mission, specific test, or series of tests.

2.6 Document Extracts

Document extracts relate to requirements placed on a given support agency resulting in the generation of additional requirements that must be placed on other agencies. Requirements relate to the lead support agency concept where one agency is given overall support responsibility when the total support involves a number of agencies.

Examples of document extracts are:

Program Requirements Document Extract (PRDE). A PRDE becomes necessary when requirements placed on a supporting agency create requirements that must be levied on other agencies. Requirements are prepared using PRD formats in accordance with the standard UDS outline.

Operation Requirements Extract (ORE). An ORE is similar to the PRDE except that it applies to the OR. It relates to the concept where the lead agency must levy requirements on other agencies. In general, basic ORE requirements will be extracted from the user's original OR and may be expanded upon by the lead agency.

2.7 Other Documentation

Program, mission, or test requirements documents must be understandable and stand on their own; however, there is some supporting information that must be

documented and related to the requirements, so support may be provided. Examples are antenna patterns, trajectory data, pyrotechnics, range safety procedures, schedules, test operation procedures, security guides, and mission go/no go rules. If this information is documented separately, it must be referenced in the UDS program documentation.

2.8 Draft Documentation Review Conferences

When PI, PRD, and OR drafts are prepared, conferences should be held to discuss the complexity of the support and to consider foreseeable difficulties. These conferences provide the opportunity to initiate program coordination, to discuss security classifications, and to assess support questions. The user agency distributes the draft and advises all interested user and support agency personnel when and if they should attend the review conference.

2.9 Document Structure

The UDS provides a building block concept to develop and to present requirements which result from incomplete program objectives to well-defined operational and developmental objectives for the system to be evaluated.

2.9.1 General

Requirements documents are extensions of each other and are used exclusively or in tandem with each other depending on the size and complexity of the program.

2.9.2 Document Outline

The UDS document outline in appendix B is a common numbering system providing standard presentation of information and serving as the framework for all documents within the UDS. Format numbers and associated titles are controlled and assigned by the RCC DG.

The UDS outline is composed of two major groups:

Formats 1000 - 1999 contain program administrative and technical information

Formats 2000 - 6999 contain test/mission operational requirements

2.9.3 UDS Formats

The UDS Formats are structured to provide a definitive area in which to state requirements and specify support agency responses. The UDS outline, coupled with pre-defined formats and instructions contained in the UDS Handbook, serves as a checklist to prevent pertinent data from being overlooked. Only those UDS Formats that best suit the needs of the particular program, mission, or test being documented should be used. The UDS documents are not to be limited to the statement of pure requirements or responses. Informational data may be provided as deemed necessary to clarify stated requirements and responses. Descriptive pictures, sketches, or graphics are encouraged. If the information or background material is voluminous, reference to a supplemental document should be considered. Supplemental documentation should be cross-referenced in the UDS document.

2.10 Document Implementation

The UDS is designed to accommodate as many conditions as practical. While it is most desirable to have single level 1 documents (that is, a PI and SC that contain total program information), it is also acceptable to have several PIs and SCs. This latter approach is used when different support agencies provide support for unique and unrelated phases of program, mission, or test. For example, one agency supports engine tests for program "X," another agency provides on-orbit support for program "X."

The same philosophy applies to level 2 documents. A single PRD and PSP will, wherever practical, contain all program level information. However, it is acceptable to have multiple PRDs and PSPs as explained above.

The most detailed level of requirements and support is contained in level 3 documents which describe specific requirements and support. The OR/OD documents will be prepared as single or multiple documents as required for effective management at the user and support agencies.

2.11 Security Classification

The originating agency of a UDS document is responsible for identifying the information to be protected including application of the proper security classification designators and any other special security markings required. When the classified sections of large documents are few in number, it may be expedient to provide

unclassified basic documents with the classified portions provided in a separate classified document extract. Classified extracts will have limited distribution and be subject to the control imposed by their classification. Classified extracts should be cross-referenced in the basic unclassified document.

2.12 Document Revision

A revision is considered to be any information added, deleted, or revised in any section of a UDS document. Revisions may be made either by preparing a completely new document or by submitting the revised information. In any case, users are requested to discuss all proposed revisions with the lead support agency. Pen and ink revisions submitted by letter are permissible for small changes; however, the changes should be incorporated into the next revision to the document. The UDS documents will reflect the revision number and date of the revision. Revisions shall be numbered consecutively beginning at 01. It is recommended that the basic document be reissued, incorporating all revisions when the number of revisions cause the document to be unmanageable. The Revision Control and Classification, Format 1030, will be used to identify the scope of the revision and shall be transmitted with any revised pages. Format 1030 also provides a historical record of revisions made to the document.

A standard change indicator or the use of the symbol "R" in the right-hand margin to identify revised lines in a format is encouraged. In subsequent revisions of a section, delete all "Rs" applicable to the preceding revision.

2.13 Document Distribution

Each document should contain its own document distribution list (Format 1020). This format lists the agencies or activities to receive the document and the number of copies each should receive. The originator will identify distribution for requirements documents.

2.14 Document Cancellation

The originator notifies the lead support agency when a PI, PRD, or OR is to be canceled.

3. USER AGENCY REQUIREMENTS DOCUMENTATION

3.1 General

Requirements documents PI, PRD, and OR are prepared by the user agency according to a schedule negotiated by the lead agency and user. The requirements for a program, mission, or test are included in a PI, PRD or OR, or in combinations as the program, mission, or test size dictate. The initial issue of each document includes the information needed to present the requirements which are known at the time of issue. Emphasis should initially be placed on identifying requirements which call for long-range planning action even though specific use or implementation details may not be known. As more information becomes available, revisions are made to incorporate the additional data. The prime consideration is to ensure the earliest possible receipt of requirement information at the support agency. The user is responsible for ensuring that requirements are promptly submitted at the request of the support agency and in accordance with scheduled lead times to allow for planning, funding, software development, and construction; that requirements documents reflect all major requirements; that all requirements are necessary to meet the program, mission/test objectives; and that all requirements have been officially approved and signed. The user is also responsible for ensuring that each requirements document contains a Format 1020 - Distribution List, and that the list identifies the number of copies needed to fulfill the user organization distribution requirements.

Support agencies will assign a document number, establish a suspense date for the publication of the resulting support documentation, notify the various support organizations of the suspense date, and publish requirements document extracts.

3.2 Requirement Priority Classification

A priority must be defined to evaluate requirements on an overall program, mission, or test basis. The three classifications, defined next, are mandatory, required, and desired.

Mandatory. A mandatory classification is the minimum requirement that is essential to achieve program, mission, or test objectives.

Required. A required priority is support that would materially aid in achieving all objectives and is necessary for detailed analysis of system performance.

Desired. A desired requirement is any support which can be obtained in addition to the mandatory or required classification.

3.3 Requirements Documentation (PI, PRD, OR)

Requirements documentation is compiled in accordance with the general instructions contained in this handbook and the appended formats.

3.3.1 Program Introduction (PI)

The PI is the document that officially introduces a program, mission, or test to a support agency and establishes the scope of program activity. Within the defined scope, the user has freedom in planning specific operations in detail.

New program requirements may impose a need for additional tracking coverage, additional data products, different frequencies, or other accommodations not available at the support range. The criteria and qualifications of such requirements should be stressed in the PI. Users with programs involving orbital operations or large weapon systems should consider the program in phases. Phase examples are pre-launch, orbital, recovery, test location, development, and system components. In these cases, the user should identify those requirements that differ and those that are unique to a particular phase. If a particular requirement is program-wide and does not differ, then such a distinction is not necessary.

3.3.2 Program Requirements Document (PRD)

The PRD, as a detailed program planning document, contains the user's desired support requirements from the support agency and may contain supplemental information needed for clarity. The need for a PRD is determined during the analysis of the PI or during early planning meetings and will be stated in the SC. The user should not delay submittal of the PRD because of incomplete knowledge of support requirements. The PRD is normally submitted by the user agency according to a schedule negotiated by the lead support agency and the user.

3.3.3 Operation Requirements (OR)

The OR is a mission-oriented document that describes in detail the program's requirements for each mission, specific test, or series of tests and is prepared

by the user. The PRD and OR must be complete documents capable of standing alone. The OR should not reflect new requirements that were not previously stated in the PI and/or PRD.

3.4 Requirements Documentation Lead Time

Lead times for initial documentation may vary considerably from program to program depending on the scope of support needed. Requirements documentation lead times are established through negotiation between the user agency and support agency. Nominal lead times in years, based on past experience, are presented next.

| PROGRAM SUPPORT REQUIRING | LEAD TIME (year) |
|--|-------------------------|
| New facility construction. | 3 ½ |
| Extensive software development or additions to instrumentation. (Not requiring major facility construction.) | 2 ½ |
| Moderate software development or instrumentation additions funded by the user. | 1 |
| Minor software development or instrumentation improvements. | 1/2 |

Table 5. Program Support Lead-Time

4. SUPPORT AGENCY RESPONSE DOCUMENTATION

4.1 General

This chapter pertains specifically to support agency documentation. Support agency response documents SC, PSP, and the OD are prepared by the support agency in response to the approved requirements prepared and submitted by the user agency. Response documents are revised by the support agency when requirements are changed or support is revised.

4.2 Support Documentation (SC, PSP, OD)

Support documentation is compiled in accordance with the general instructions contained in this handbook and the appended formats.

4.2.1 Statement of Capability (SC)

The SC provides a response to the user's PI. The PI, in combination with the approved SC, forms a basic agreement between the user and the support agency and guides the more detailed planning directives to support organizations.

Wherever possible, the SC responds to the PI on an item-for-item basis. Responses may be presented in the general section of each UDS format when further breakdown is not warranted. In some cases, the support agency may respond to the PI on an exception basis rather than with a definitive support plan. Also at the discretion of the support agency, commonly supplied items and requirements that can be satisfied with existing capability may be answered in a general all-inclusive statement. The approach taken depends generally on the nature and the purpose of the program.

When the support agency capability will not meet the requirements stated in the PI, the SC specifies such restraints and limitations. The SC may also serve to support funding policy directives, provide a rough order of magnitude (ROM) cost estimates, and assign existing facilities such as launch complexes, office space, assembly, and storage areas available to meet requirements stated in the PI. If the user requires new construction, the SC may provide site approval by the support agency.

4.2.2 Program Support Plan (PSP)

The PSP is the support agency's response to the PRD. The initial PSP issue includes an item-for-item response to the program requirements which are known at the time of issue and stated in the PRD.

4.2.3 Operations Directive (OD)

The OD is the support agency's response to the OR and details each support function, the support equipment, the technical configuration, and the personnel duties involved in supporting the test or operation. The OD may provide management information or technical requirements and guidelines. It is a listing of expected coverage detailing the support posture of the support agency for the test covered by the particular OD. The OD is normally prepared in sufficient detail to furnish instructions for a specific test or test series.

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APPENDIX E. EXCERPTS FROM U.S. MARINE CORPS DEVELOPMENTAL TEST AND EVALUATION HANDBOOK

[Ref. 12]

A. MAJOR RANGE AND TEST FACILITY BASE

This paper provides a synopsis of DoD test facilities for quick reference. More detailed information on the capabilities may be obtained from the test facility websites.

B. ARMY

1. Aberdeen Test Center

<http://www.atc.army.mil/ATC.html> (410) 278-4639.

Aberdeen Test Center (ATC) is located on the East Coast in central Maryland. ATC encompasses 56,707 acres of engineered and dedicated land and water. With complex instrumented roadways and ranges, this establishment includes maintenance shops with precision fabrication facilities. This DoD test center has accredited analytical laboratories with specialized testing facilities and courses. ATC has full-scale customized testing fixtures that are versatile, interchangeable and readily reconfigurable with advanced instrumentation suites for customized test configurations.

Aberdeen Test Center accommodates industry, academia and government programs for all weight class wheeled and tracked vehicles. This full-spectrum, 21st century, technoscientific test facility supports material handling equipment, robotic, maritime, electronic, and foreign systems. ATC also supports advanced transportation technologies systems signatures and sensor characterization. Large and small caliber ammunition, weaponry, training requirements and assessments are also supported.

2. Dugway Proving Ground

<http://www.dugway.army.mil/> (801) 522-3531

The U.S. Army Dugway Proving Ground (DPG), Dugway, Utah. DPG tests chemical and biological materiel, smoke, obscurants, and incendiary devices, artillery and mortars, and tropic natural environmental effects on all materiel. Facilities include instrumented outdoor test grids to measure effectiveness of smokes, obscurants, and dispersal of chemical munitions using stimulants; chemical and biological laboratories;

an indoor test chamber to subject systems as large as a tank to chemical, biological, and environmental challenges; and mortar and artillery ranges out to 65,000 meters.

3. Electronic Proving Ground

<http://huachucawww1.army.mil/Epg/> (520) 538-6891

U.S. Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona. USAEPG tests systems with regard to communications, command and control, optics and electro-optics, intelligence, electronic warfare, avionics, and TEMPEST. Facilities include an instrumented test range, an electromagnetic environmental test facility, environmental facilities to satisfy the requirements of MIL-STD 810, a stress loading facility to provide a threat electromagnetic environment and measure the full load performance of communications systems, and many unique specialized facilities for testing of antennas, radars, remotely piloted vehicles, and computer software.

4. Kwajalein Missile Range

<http://www.smdc.army.mil/kmr.html> (256) 955-3100

Kwajalein Missile Range (KMR), U.S. Army Kwajalein Atoll (USAKA), Republic of the Marshall Islands. KMR's isolated location makes it ideal for testing the full performance envelope of developmental and operational ballistic missile systems with minimal safety and environmental constraints. KMR provides range radar tracking, impact scoring, recovery, and telemetry data collection for intercontinental and theater ballistic missiles, orbital objects, and reentry vehicles. Facilities include a broad range of ground and mobile instrumentation, radar tracking and imaging, telemetry, and splash detection radars, and large aperture optical sensors. Intercontinental ballistic missiles can be launched from CA (4,840 miles), intermediate-range missiles from Hawaii (2,430 miles), shorter range theater missile defense-type missiles from Wake Island (730 miles), and other alternate launch sites (250-450 miles). The natural configuration of the atoll (more than 90 islands forming the world's largest lagoon) facilitates tracking and recovery of reentry vehicles and local launches with minimal safety and environmental constraints.

5. Yuma Proving Ground

<http://www.yuma.army.mil/> (602) 328-3111

U.S. Army Yuma Proving Ground (YPG), Yuma, Arizona. YPG tests long range artillery, automotive systems, armored vehicles and armament, aircraft armament and fire control systems, air delivery and air transport systems, aircraft and vehicle navigation systems, target acquisition and sensor systems, remotely piloted vehicles, and natural desert environmental effects on all weapons systems and materiel. Facilities include fully instrumented land and water air delivery drop zones, firing ranges from small arms to artillery out to 75,000 meters, air to ground aircraft armament range, tank gunnery range, navigation system range, and a full array of ground vehicle mobility test courses. YPG is the Army's natural environmental test activity. The hot-dry natural desert environment provides diverse terrain representative of almost all of the world's desert areas.

Facilities also include two remote sites for tropic and cold weather testing. A remote test site in Panama tests the full range of Army weapons systems, clothing, and individual equipment for effects of operation and long term exposure in natural tropical environments. The Cold Regions Test Activity, located at Fort Greely, Alaska, conducts basic cold environment tests on all materiel as prescribed by AR 70-38. Facilities include artillery ranges to 55,000 meters, tank ranges to 4000 meters, vehicle courses, chemical (simulant) and smoke test grids, mobile instrumentation vans, ski trails, and large expanses in which to test full systems operationally in the natural winter environment. Conditions include snow to seven feet deep, ice fog, permafrost tundra, temperatures in the $-5\pm$ to $-25\pm$ F range during most of the winter, with temperatures often dipping below $-50\pm$ F.

6. White Sands Missile Range

<http://www.wsmr.army.mil/> (915) 678-5755/3715

U.S. Army White Sands Missile Range (WSMR), New Mexico. The WSMR tests missile systems and related materiel, air defense systems, laser weapons systems, and nuclear effects on all systems. Facilities include on-range and off-range missile launch facilities providing up to 800 miles over-land trajectory; flight ranges highly instrumented with radars, cinetheodolites, telemetry, optics, laser trackers and command,

control and command destruct systems; a laser test range; and target drone control facility. Specialized environmental facilities provide nuclear effects, electromagnetic radiation, microbiological, climatic, and dynamic test environments.

C. AIR FORCE

1. Arnold Engineering Development Center

<http://www.arnold.af.mil> (931) 454-3000

One of the Air Force Materiel Command's major test centers, AEDC is located in Middle Tennessee approximately equidistant from Nashville, Chattanooga, and Huntsville, Alabama. AEDC is responsible for conducting development, certification, and qualification testing of aircraft, missile, and space systems. As a Department of Defense Major Range and Test Facility Base (MRTFB) installation, AEDC is prohibited from competing with industry in its testing and test support activities. However, AEDC may provide services to private industry when those services are not reasonably available within the private sector. Reasons for determining that a private sector source does not meet the commercial customer's needs include, but are not limited to: insufficient technical capability, lack of appropriate security, or inability of facility or capability to meet schedule needs. Lower cost of an MRTFB facility or capability, standing alone, is not an acceptable basis for a commercial customer to request use of MRTFB facilities in lieu of those available in the private sector. Certification is required to assure that AEDC meets the requirements for non-competition with industry.

2. Utah Test and Training Range

<http://www.hill.af.mil/> (801) 777-1110

Hill Air Force Base is an Air Force Materiel Command base located in northern Utah. The base is home to many operational and support missions with the Ogden Air Logistics Center (OO-ALC) serving as the host organization.

Developmental Test: Utah Test and Training Range (UTTR) is the perfect location for developmental test and evaluation support for cruise missiles, unmanned air vehicles, and munitions. The land and airspace, combined with our modern data collection/processing capabilities and test expertise, provide unmatched support for developmental tests of advanced weapons systems. Operational Test: UTTR blends

modern developmental test capabilities with a realistic environment for training to produce the finest operational test range in the United States. Our vast range contains the largest overland safety footprint available in the Department of Defense. Training-UTTR can support over 30,000 training sorties annually with capabilities for air-to-ground, ground-to-air, and ground exercises -- in any combination. An extensive variety of realistic targets within the 6 complexes are available to meet any training need -- from scorable target pads to remotely controlled realistic threats.

3. U.S. AF 46th Test Group

<http://www.holloman.af.mil/46tg/index.html> (505) 475-6511

The 46th Test Group at Holloman AFB, New Mexico, is a unit of the 46th Test Wing, Air Force Development Test Center, Eglin AFB, FL. The Test Group's mission is to operate world-class test facilities for high speed sled track testing, navigation and guidance system testing, radar signature measurements, and weapon systems flight testing including airspace control of the WSMR. The 46th Test Group, the largest tenant unit at Holloman Air Force Base, is part of the Air Force Materiel Command.

4. Air Force Development Test Center:

<http://www.eglin.af.mil/> (904) 882-3488

The Air Force Development Test Center (AFDTC) is located at Eglin AFB, 7 miles northeast of Fort Walton Beach, Florida. AFDTC is the parent organization to the 46th Test Wing (TW), which conducts the DT&E and OT&E mission at Eglin AFB. The 46th TW also manages test facilities located at Holloman AFB, New Mexico; Fort Worth, Texas; and Buffalo, New York.

Central Control Facility (CCF) contains a full range of state-of-the-art computing capabilities including a Cray Y-MP supercomputer integrated into a high-speed network of DECVAX, Silicon Graphics front-end, and workstations. The CCF supports in-depth analysis and provides the capability for real-time control during simultaneous test missions.

5. Air Force Flight Test Center:

www.edwards.af.mil (661) 277-3837

The Air Force Flight Test Center at Edwards Air Force Base, California, can meet a wide variety of TSPI flight test analysis needs by providing trajectory information of many types in virtually any form required by our customers, and specialized needs can be met in an efficient and timely manner.

The Air Force Flight Test Center provides many facilities geared towards a vast array of testing capabilities. The Single Face To the Customer (SFTC) office will assist the test customer; typically a system program office (SPO), a MAJCOM, or an AFOTEC program or industry contractor with initial test planning. This may include providing test options, assisting with the development of the Test and Evaluation Master Plan, or recommending a Responsible Test Organization (RTO). It is the responsibility of the SFTC to help the customer take best advantage of the Air Force's Test Process. The SFTC can identify and recommend the optimum combination of test resources that are available throughout the Air Force and the DoD. Once the test customer has selected a RTO to conduct the test program, the SFTC is available to further assist and collect valuable lessons-learned from each testing application. The SFTC in the application of the Air Force Test Process provides continuity and consistency in the test and evaluation of a weapons system in development or modernization.

6. 30th Space Wing

<http://www.30sw.vafb.af.mil/> (800) 569-0029

Headquartered at Vandenberg AFB on the Central California coast, the 30th Space Wing is the Air Force Space Command organization responsible for all government space and missile launch activities on the West Coast. Vandenberg AFB is serviced by a 15,000-ft runway, a boat dock, a railway system, and major highways. The Wing manages the Western Range, which extends from the California Coast westward to the Indian Ocean. In conjunction with other test ranges, principally the Naval Air Warfare Center Weapons Division, Point Mugu, and the Army Kwajalein Missile Range, the Western Range provides continuous and complimentary instrumentation coverage over a broad portion of the Pacific Ocean.

The 30th Space Wing offers an extensive array of world class spacelift and ICBM facilities. Spacelift facilities include space launch complexes and large checkout and assembly facilities for Titan, Delta, Atlas, and other government and commercial programs. Various payloads, including the nation's largest satellites, are processed at Vandenberg AFB. Ballistic launch and processing facilities support Minuteman and Peacekeeper ICBM programs. Space and ballistic missile launches are possible across a wide range of launch azimuths. This allows direct polar orbit insertion of satellites and ICBM testing without overflight of populated areas. Vandenberg is the only location in the continental United States permitting direct polar orbit spacelift launches without overflying any land mass.

7. 45th Space Wing

<http://www.acq.osd.mil/te/pubfac/45thspace.html/> (407) 494-4500

Patrick Air Force Base serves as headquarters to the 45th Space Wing and is located on Highway A1A, three miles south of Cocoa Beach, and 69 miles east of Orlando. The base is situated between the Banana River and the Atlantic Ocean. The 1822-acre area is 4.1 miles from north to south, 1.25 miles from east to west, and 9 feet above sea level.

The 45th Space Wing provides spacecraft processing, launch and tracking facilities, safety procedures, and test data to a wide variety of customers and manages launch operations for DoD space programs. The customers include the Air Force, Army, Navy, the National Aeronautics and Space Administration, foreign governments, and private industry. Facilities include launch complexes, booster and payload assembly buildings, and all other elements essential to the assembly, pre-launch, launch, and post-launch operations of space/ballistic vehicles.

8. Air Force Air Warfare Center (Nellis Range Complex)

<http://www.nellis.af.mil/cgi-shl/redirect.pl> (702)643-3643

The Nellis Range Complex is located between Las Vegas and Tonopah in Southwestern Nevada and consists of five adjacent geographical areas. The ground is mostly barren, consisting mainly of flat, dry lake beds, dry washes, desert vegetation, and rugged, mountainous terrain. The land occupied by the NRC is more than 3.1 million

acres, combined with more than 12,000 square miles of airspace. The 99th Range Squadron, which controls the range, is located on Nellis Air Force Base, approximately eight miles northeast of Las Vegas.

The Nellis Range Complex maintains the most realistic integrated threat simulator environment in the free world. In addition to the wide assortment of surface-to-air missiles, anti-aircraft artillery, and acquisition radars operated by Range Squadron personnel from 39th Intelligence Squadron, maintain and operate a variety of radar and communications jamming equipment. Coupled with the Nellis Red Flag Measurement and Debriefing System, these assets provide superior year-round training to U.S. and allied aircrews in both competition and training exercises.

9. 99th Range Group

<http://acq.osd.mil/te/pubfac/nellis.html> (702) 652-3620

The 99th Range Squadron, which controls the range, is located on Nellis Air Force Base, approximately eight miles northeast of Las Vegas. The 99th Range Group (ACC) operates, maintains, and develops four geographically separated electronic scoring sites, an instrumentation support facility, and the 3.1-million-acre Nellis Range Complex, including two emergency/divert airfields. It formulates concepts and advocates requirements to support Departments of Defense and Energy advanced composite training, tactics development, electronic combat, testing, and research and development.

D. MARINE CORPS

• Amphibious Vehicle Test Branch

<http://avtb.cpp.usmc.ml> (760) 725-2016

The Amphibious Vehicle Test Branch (AVTB) is located in the Del Mar area of Camp Pendleton, California, and offers year-round temperate climate, diverse terrain, and 17 miles of coastline ideal for amphibious vehicle testing. Its close proximity to San Diego enhances ship-related testing. Camp Pendleton also offers range facilities to conduct live-fire testing of vehicular armament and weapons systems. Training facilities, operating areas, and ranges are all under U.S. Marine Corps control. AVTB is in close proximity to San Clemente Island, which can be used for live-fire sea-to-shore testing and high-speed water testing. In addition, terrain/test-specific areas such as Marine Corps Air

Ground Combat Center Twenty-nine Palms, Naval Amphibious Base Coronado and Yuma Proving Grounds are close enough to be easily available for use. Conference facilities are on-site and include audio-visual aid equipment.

AVTB supports the requirements for all services as the only Department of Defense certified facility for testing amphibious vehicles and associated equipment. This includes conducting developmental testing, combined developmental operational testing, follow-on testing, and evaluation of production hardware, production assurance testing, and substitute or alternate part and material testing.

Note: Although this is not an MRTFB, this is the only Marine Corps Test Facility.

E. NAVY

1. Atlantic Fleet Weapons Training Facility

<http://www.nctspr.navy.mil:80/index/html/> (888) 800-4873

Atlantic Fleet Weapons Training Facility (AFWTF) is a shore activity at Naval Station Roosevelt Roads, Puerto Rico. It serves as the Navy's premier training range for ensuring combat readiness of Atlantic Fleet Forces. AFWTF's ranges allow the simultaneous conduct of gunnery, missile firings, air-to-ground ordnance delivery, electronic warfare, and underwater operations, all coordinated with accurate scoring and recording.

AFWTF facilities are located at numerous sites throughout the Caribbean on the islands of St. Croix, St. Thomas, Vieques, and Puerto Rico. The moderate tropical climate is ideal for training exercises. Cancellations due to inclement weather are very rare.

2. Atlantic Undersea Test and Evaluation Center

<http://npt.nuwc.navy.mil/autec/> (800) 669-6892 Ext.13369

Major test support facilities on Andros Island are located at Site 1 in the Command Control Building and Range Support Facility. The Command Control Building houses the range tracking displays and replay centers, the computer center, photo lab, communications center and the central timing system.

The Range Support Facility houses a torpedo post-run workshop, Mk 46/Mk 50 Intermediate Maintenance Activities (IMA), a Target Mk 30 IMA, a Mk 48 R&D Turnaround and extensive technical laboratory facilities. The complex includes electrical and physical calibration labs, a complete electronics maintenance shop, a dive locker, a precision machine shop/office and logistic spaces. The Atlantic Undersea Test and Evaluation Center has a 285-foot long concrete pier with a controlling depth of 17 feet (5.2 meters) at mean low tide. An adjacent wharf is approximately 240 feet long (72 meters) with a controlling depth of 15 feet at mean low tide. 440 volts alternating current power is available at both locations (200 and 60 Amp at the pier and 60 Amp at the wharf). Facilities at the pier/marine area include fully equipped machine/fabrication and marine overhaul shops. At site 1 there are six Range User Buildings available to range users for assembling test equipment and equipment check-outs during a mobilization or dockside period. These staging areas are equipped with a variety of power sources, gantry cranes, compressed air and other minimal to maximum-security capabilities. A fully equipped range user hanger, for ground maintenance and storage of helicopters, is located adjacent to the helicopter landing area.

3. Naval Air Warfare Center -- Weapons Division:

Naval Air Warfare Center Weapons Division China Lake

<http://nawcwpns.navy.mil/> (760) 939-1074

The Naval Air Warfare Center Weapons Division (NAWCWPNS), China Lake, is located in Kern County in the upper Mojave Desert of Southern California, about 150 miles north of Los Angeles. China Lake is accessible by air through the town of Inyokern and by highways US 395 and California 14. NAWCWPNS China Lake covers over 1700 square miles of restricted land space underlying the R-2508 restricted air space. The climate and geography of these lands are typical of the arid regions of the U.S. Southwest. The weather is usually clear, with very little precipitation and practically unlimited visibility throughout most of the year. The terrain includes flat dry lake beds, large dry washes, alluvial fans, and both desert and piñon and cedar forest covered mountains. Nearly all the land is used exclusively for test and evaluation.

This is a test and evaluation and training support organization developing and operating major land, sea, and air range and test facilities and associated threat environments for DoD RDT&E and operational customers. A Naval Air Systems Command initiative has transformed site-oriented operations to a more effective and efficient competency-aligned operation. As part of this initiative, the Pacific Ranges and Facilities Department was established to integrate the unique capabilities of the Navy's West Coast T&E ranges at Point Mugu, China Lake, and the Navy Detachment at White Sands Missile Range. This brochure describes the assets at China Lake.

4. Naval Air Warfare Center, Weapons Division, Point Mugu

<http://www.nawcwpns.navy.mil/~pacrange/sea.html> (805) 989-8751

The Sea Range provides a large, instrumented, controlled arena for test and training in a maritime environment. Centered at Point Mugu, the Sea Range is fully instrumented over its 125,000 square miles, providing an expansive open-air and-sea environment in which to safely conduct controlled air-, surface-, and subsurface-launched weapons tests. The Range supports a broad array of scenarios, from one-on-one tests to complex multi target operations in dense electronic combat environments. In addition, the Sea Range regularly conducts complex, full-battle-group Fleet exercises involving aircraft, surface ships, and submarines against a variety of air and sea targets and threats.

Extending inland from the Sea Range is IR-200, an FAA-approved flight route joining the Sea Range with the 20,000-square-mile Joint Service Restricted Airspace Complex, R-2508, of which China Lake's ranges are a part. a full-spectrum Test complex for conventional weapons and aircraft systems.

5. Naval Air Warfare Center - Aircraft Division:

<http://www.nawcad.navy.mil/nawcad/test> eval/index.html

<http://www.nawcad.navy.mil/pax> (301) 342-3427

The Naval Air Warfare Center - Aircraft Division (NAWCAD) T&E Group is the steward of the ranges, major facilities, and most of the aircraft located on board the Naval Air Station at Patuxent River, Maryland. The bulk of the active duty military is assigned to the T&E Group, and we are the proud home of the United States Naval Test Pilot School. The Test and Evaluation (T&E) TEAM at NAWCAD Patuxent River, MD is the

supplier of choice for life cycle test and evaluation. We support the Naval Aviation Systems Team in the development and fielding of quality aviation vehicles, weapons systems and related products for the Operating Forces. Our people, processes, facilities, resources and leadership are dedicated to satisfying the test and training requirements of the Navy program managers, fleet operators and other customers.

F. DEFENSE INFORMATION SYSTEMS AGENCY

- **Joint Interoperability Test Command**

<http://jitic-emh.army.mil/welcome.htm> - (800) LET-JITC

The Joint Interoperability Test Command (JITC) is the Department of Defense's facility for evaluating the interoperability of command, control, communication, computers, and intelligence and combat support systems. It also conducts a wide range of developmental, operational and standards conformance tests for private industry, the Joint Staff, US and allied military Services, Commanders-in-Chief, and several Federal agencies.

The JITC is the place for "one-stop systems testing" with its one-of-a-kind array of hardware, software and staffing, along with its state-of-the-art technological flexibility. The command can interface all its on-site capabilities and network with any other testing or operational facility worldwide. The JITC is located at Fort Huachuca, AZ, about an hour and a half drive southeast of Tucson. Tests data, message, and circuit switching systems and equipment ranging from tactical, squad level systems, to strategic, headquarters level systems. Tests every kind of transmission system including tactical line-of-sight; combat net radios; high frequency, microwave and tropospheric scatter systems; fiber optic cable; commercial telephone lines; and satellite links. Uses traffic and message loading devices to simulate high volume conditions.

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